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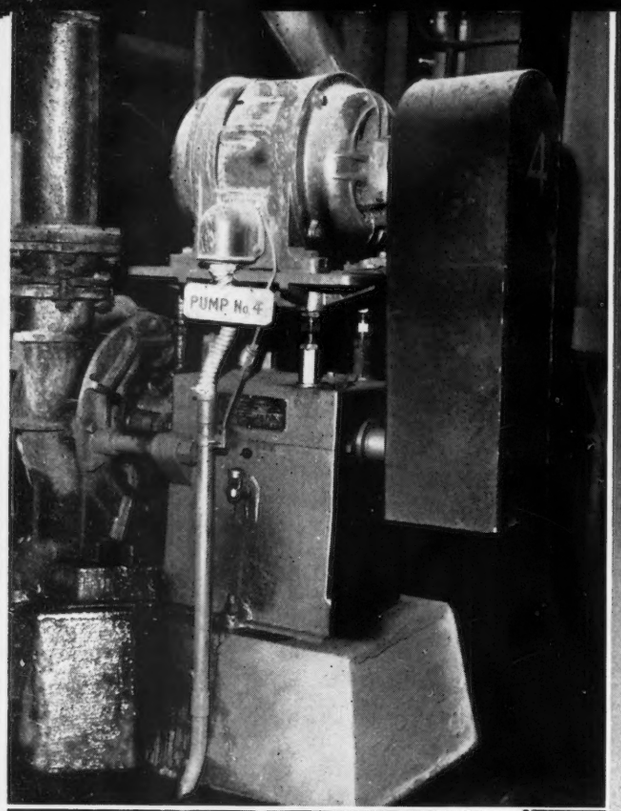
ENGINEERING AND MINING JOURNAL

DECEMBER, 1940

oading sulphur from a vat of the Texas
ulf Sulphur Company at Newgulf, Texas

In this issue

Bolivian Tin for the United States
Gold North of Great Slave Lake
Roasting Blue Ores • Drilling at Jardine
The Sliger Gold Mine • Selecting the Crusher
Blasting With Detonating Fuse
Complete contents on page 27



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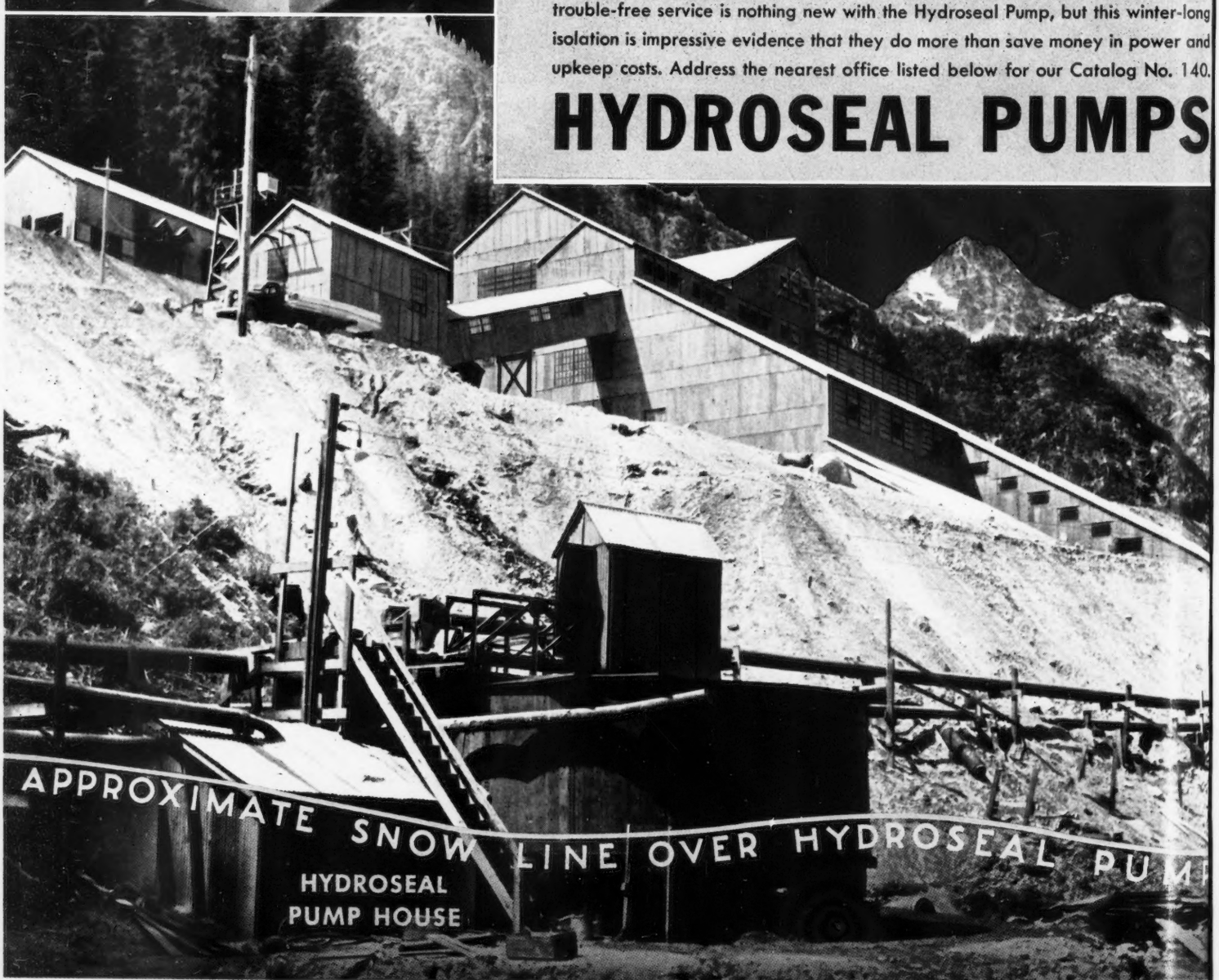

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Drill steel shanks may seem just another equipment detail to some, but it can be shown that omission to prepare and maintain them properly has its effect upon drill repair costs. F. R. Anderson, metallurgist for a prominent manufacturer, says that failure of striking faces is perhaps the most serious of the difficulties met. He will discuss the subject in the January issue, illustrating his points with numerous photos of rock-drill parts from the shop.

▼

Ground barite has been finding increasing application for weighting drilling mud in oil-field work. For such use a non-settling characteristic is advantageous in that the material will remain in suspension in the fluid, even when circulation in the well is stopped for several months. The product of National Lead's barytes plant at El Portal, Calif., is said to have this quality. Mining and preparation as conducted here will be described in January by A. C. Harding.

▼

Lake Superior iron ore operators in the 1940 season have missed breaking the record for ore shipments down the Lakes by only a narrow margin, despite a lagging start. They are looking forward to a big year in 1941 and are making plans accordingly. Opportunely, M. D. Harbaugh, vice-president of the Lake Superior Iron Ore Association, has recently estimated from reliable sources the annual requirements of Lake ore that would be imposed by the full operation of United States and Canadian blast furnaces which use or may be expected to use such ore in a period of continued emergency. Assuming practically capacity operations in the steel industry, he puts these requirements at 79,081,000 tons. He finds, moreover, that the combined capacity of the Great Lake fleets of ore carriers — American and Canadian, a total of more than 300 vessels—would be adequate for a movement of this magnitude. It may reasonably be expected then that 1941 will see established a new record for iron ore shipments.

H. C. PARMELEE
Editor

ENGINEERING AND MINING JOURNAL

H. W. CLARKE
Vice-President

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Contents for DECEMBER 1940

Vol. 141, No. 12

Copyright 1940 McGraw-Hill Publishing Co., Inc.

Editorials 31

Mining Gold North of Great Slave Lake 33
John Murray McMeekan

Roasting the Blue Ores of the Black Hills 37
E. C. Brace

At the Sliger Gold Mine 39
John B. Huttl

How to Select the Crusher 41
Stanley D. Michaelson

Determining the Power Cable for Carlton Tunnel 46
S. J. Kester

The Haultain Superpanner Improved 47
Henry De Rycker Maurice Rey

A Technique of Blasting With Detonating Fuse 48
Paul C. Ziemke

One-Man Diamond Drill Proves Worth at Jardine 52
L. F. McCurdy

Phosphate—The Vital Non-Metallic—IV 53
A. H. Hubbell

Bolivian Tin for the United States 60
(Abstract of Government Contract)

Summary of the Markets 62

Personal Items, Obituaries 65

News of the Industry 69

Equipment News 91

COVER ILLUSTRATION: Loading sulphur at a vat of Texas Gulf Sulphur Company at Newgulf, Texas. Atlas photo by Robert Yarnell Richie. Cover space released for editorial use by Eimco Corporation

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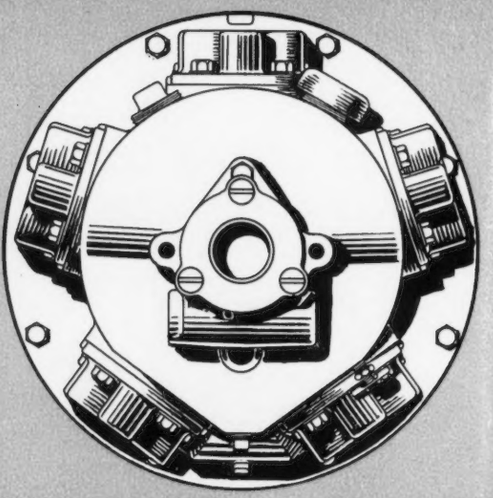

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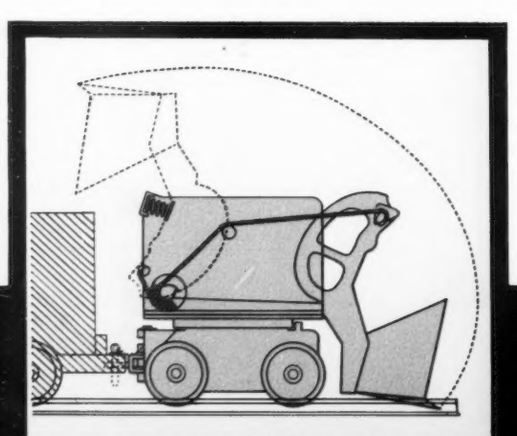

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Volume 141 DECEMBER, 1940 Number 12

Tanks Don't Have Pups

SUCH IS THE ARRESTING TITLE of a brochure published by *Factory Management and Maintenance* to interpret the time element involved in executing the national defense program. The catchy phrase is a cryptic answer to those uninformed or insincere critics who decry what seems to be the tortoise pace of the rearmament program, and who, by inference, lay the delay at the door of industry.

Airplanes, anti-aircraft guns, tanks, and battleships do not reproduce their kind. They must first be designed. Raw materials and parts must be provided by hundreds of processors and fabricators. Factories must be built or enlarged. Personnel must be found and trained. The production capacity of an entire nation must be coordinated to superimpose an armament program on the normal peace-time activities of industry. It is a huge undertaking.

Enlightening is the estimate of Army and Navy officials that, for an armed force considered to be the minimum for national defense, it will take from 12 to 18 months to make the desired number of bombing planes, 16 to 20 months for anti-aircraft guns, 18 to 24 months for tanks, 30 months for heavy guns, and 48 to 52 months for battleships. The wonder is not that actual production gets under way so slowly, but that it proceeds as rapidly as it does and with so little disruption of peace-time economy.

U. S. Buys Bolivian Tin Ore

BECAUSE of the unusual historical and political character of the transaction, we publish on page 60 the salient features of the agreement under which the United States will purchase from Bolivian producers during the next five years a quantity of tin ore calculated to yield 90,000 long tons of fine tin.

The contract has its novel aspects, which are not likely to be understood unless the political significance of the whole transaction is emphasized. The deal is far more important politically than in the economic sense. It exemplifies clearly the policy of the United States to promote solidarity in the Western Hemisphere as a means of resisting economic aggression by the totalitarian powers.

True, we need the tin and would like to have a stockpile in reserve; but if that were the sole consideration we should probably buy Straits pig tin and avoid the metallurgical difficulty of treating the relatively impure Bolivian ores. Then there is the valid argument that shipping between the Americas is much less likely to be disrupted than between the East Indies and the United States, and that Bolivia offers a more certain source of the metal. Finally, something is to be said for the desirability of establishing in the United States a tin-smelting industry that will continue to function after the war is over.

But admitting all of these arguments, the fact remains that the tin ore contract establishes close political ties between the United States and Bolivia, improving the latter's trade balance in this country and providing her with dollar exchange. It is the good neighbor policy in action, of which we shall see more rather than less as steps are taken for hemisphere coordination and defense. Nor is the policy confined to our international relations in the Americas. On no other basis can our present generous loans to China be explained or justified.

Reverting to the Bolivian tin ore contract, metallurgists will note an anomaly in the smelting charges for the ores of Group C—18–35 per cent

tin, average 25 per cent. In this group the smelting charge is *increased* as the grade of the ore *rises* above the average of 25 per cent, and *decreased* as it *falls below*. This particular schedule has been the subject of sharp criticism, first because such low-grade, impure ores are included in the agreement; and second because of the curious reversal of the usual practice of *reducing* treatment charges as the grade of ore *rises*, and vice versa. Fear has been expressed that somebody is "putting something over" on Uncle Sam.

Diligent editorial inquiry leads us to believe that such is not the case; that ores of this grade have previously been sold on these terms by a Bolivian producer to buyers in England, Holland, and Germany; that the anomaly in treatment charges is more apparent than real; and that the terms were purposely made favorable to the producer in order to encourage the output of this low-grade material. To which we add the emphatic note that the contract must be interpreted more in terms of hemisphere politics rather than of economics and technology.

Kennecott Adopts Retirement Plan

INDICATIVE of a forward-looking personnel policy, Kennecott Copper Corporation instituted on November 1, 1940, a retirement plan for employees receiving more than $3,000 a year in salary. Retirement benefits vary with years of service and average annual salary during the last ten years before retirement. Benefits are purchased by monthly contributions in equal amounts by employee and employer, plus such additional annual contributions by the employer as actuarial experience may show to be necessary to insure the payment of benefits set forth in a schedule. Normal retirement age is 65 for men and 60 for women. Benefits based on not less than 20 years of service range from $900 to a maximum of $25,000 a year. Employee contributions, of course, vary proportionately with salary and benefits. In adopting this plan Kennecott recognizes two vital factors in the success of a great industrial enterprise: First, that an organization grows great only as a result of the skill and loyalty of employees who give their lives to its service; second, that continued success depends on giving younger employees an incentive to continue in the service of the enterprise in the hope and expectation of replacing their elders when the latter have retired. No greater obligation exists in a modern industrial organization than to insure employees against the hazards of the future. Kennecott is to be congratulated on its action.

Renovating the N.L.R.B.

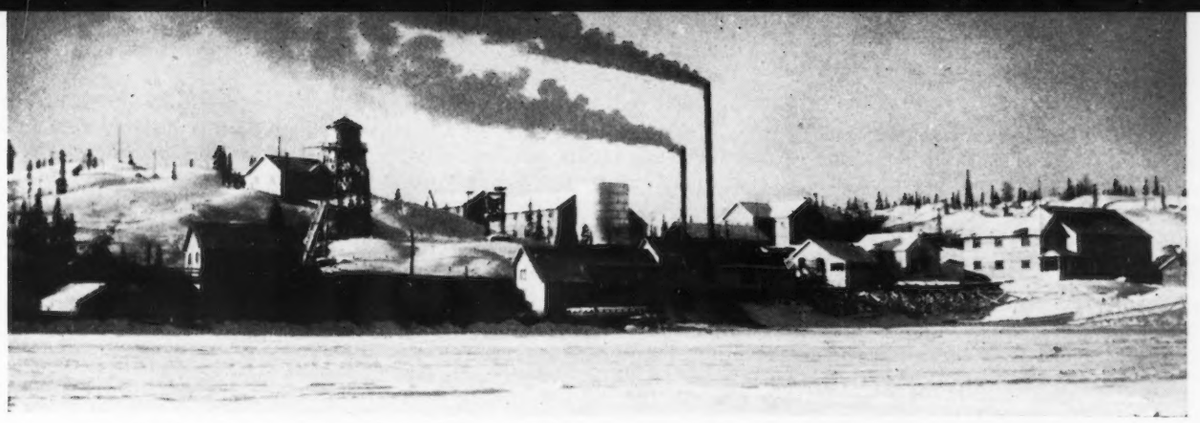
WITH THE APPOINTMENT and confirmation of Dr. Harry A. Millis as chairman of the National Labor Relations Board, employers can look forward hopefully to fairer treatment in the settlement of labor disputes. Hitherto they have not only suffered from the inherent inequities of the National Labor Relations Act, but they have also been victims of the prejudices of a majority of the Board. Happily, Mr. Madden has now been succeeded by Dr. Millis, who, with Dr. Leiserson, may be expected to form a majority that will restore public confidence in the Board's integrity. And member Edwin F. Smith, whose nefarious activities were revealed by Congressional inquiry, will, we hope, be reduced to an impotent minority. With these changes in the complexion of the Board, and the resignation of Secretary Witt, a good start will have been made toward cleaning up the N.L.R.B., a process which should proceed down through the ranks of subordinates until the Board commands public respect for its personnel and decisions. Nothing short of thorough renovation will accomplish that end.

Canadian Engineers Join E.C.P.D.

NO FINER COMPLIMENT could be paid to the policies and activities of the Engineers' Council for Professional Development than the desire and willingness of the Engineering Institute of Canada to become a participating body of the Council. The E.C.P.D. honored itself and took a long step toward professional solidarity in America when, at its annual meeting in Pittsburgh on October 24, it welcomed the Canadian organization to membership. Mutual benefits may be expected to flow from this new association as leaders in both countries exchange views on problems of engineering education, development, and recognition. The last, particularly, has been a knotty problem for E.C.P.D. Less progress has been made toward the acceptance of standards of professional recognition than in any other aspect of the work. Perhaps our Canadian friends can make a helpful contribution to the solution of a problem that has thus far baffled their professional brothers in the United States.

ANNUAL INDEX

THE ANNUAL INDEX to the current volume of *Engineering and Mining Journal* is bound in this number at page 106.



The Con mine of the Consolidated Mining & Smelting Company of Canada, on Yellowknife Bay, Northwest Territories

MINING GOLD
North of Great Slave Lake

Seven years of development in North America's newest important productive area

John Murray McMeekan
Yellowknife, Northwest Territories, Canada

HARD-ROCK gold mining in the Canadian Northwest Territories dates from the summer of 1933, when a prospecting party, sent out from the pitchblende-silver camp, on Great Bear Lake, made the first discoveries on the Yellowknife River, some 35 miles from the mouth, where the river empties into Great Slave Lake. In 1934, a narrow quartz vein carrying visible gold was found on the east shore of Yellowknife Bay. During 1935 reports of the excellent results which were being obtained in preliminary work done on this vein attracted the attention of several mining exploration companies and led to their sending parties to the field, which made several discoveries of gold-bearing veins on the west shore of the bay. Ensuing wildcat and location staking led to the registering of claims for more than 40 miles up the Yellowknife Valley.

During 1936, prospecting parties, spreading from Yellowknife, which is a natural focal point, with a good harbor and a good plane-landing location, made other discoveries, notably on Gordon Lake, 65 miles northeast of the bay.

The following year saw the starting of development on the "Con" property of Consolidated Mining & Smelting Company and the adjoining Negus group, on the west shore of Yellowknife Bay. High-grade ore was also brought to light on the Giant group, farther north up the west shore.

During 1938, a spectacular find was made on Thompson Lake, 35 miles northeast of Yellowknife and, in the late summer, the first gold brick was poured on the Con. Finds were also made in the Beaulieu-Francois river valleys, 60 to 70 miles east and, just before freeze-up, at Wray Lake, 120 miles to the northwest.

In February 1939, the Negus entered production and serious development was begun on the Lily-Jack group, staked three years before, which had been bought by Consolidated Mining & Smelting Company. Finds were also made in the Campbell Lake-Desperation Lake area, which is situated 50 miles east.

In 1937 the beginnings of a settlement had appeared on a peninsula on the west shore of the bay. Today the town of Yellowknife has a fixed population of approximately 500 people and is the center of a newly created Administrative District which extends from the town for 3½ miles in every direction.

Means of Access to the Field—Situated thus, on the north shore of Great Slave Lake, 850 miles from Edmonton, which is the starting point for expeditions into the North and the nearest distributing point for supplies and equipment, it would appear superficially that the Yellowknife field is remote from sources of supply to a degree which would render the operation of anything but a very rich mining undertaking out of the question. Actually, however, freight from Edmonton is shipped by way of the Northern Alberta Railroad to Waterways and thence loaded on boats and barges, by which it is carried as far as Fitzgerald, where the only transshipment in the whole remaining 600 miles of transportation is necessary. After a 15-mile haul across the portage by truck, there is no further need for unloading until Yellowknife is reached. Freight rates from Waterways to Yellowknife are $37.50 a ton. By the construction of a marine railroad over the portage, which would enable scows and barges to be taken across on rail chassis without unloading, this not-excessive cost could be still further reduced. Four companies handle the water-borne freight.

Aërial Transportation—Though heavy equipment and supplies are brought in by water or, in winter, to a certain extent by tractor train, passenger traffic, mail, and light-weight freight is handled exclusively by airplane. Three aërial transportation companies operate in the country, two of which, Canadian Airways and Mackenzie Air Service, fly from Edmonton; the other, Peace River Airways, flies from the farming towns of the Peace River area. These planes are equipped with pontoons for summer work, skiis for winter. It is not uncommon for seven or eight planes, with passenger capacity of from six to twelve persons, to be tied up overnight at the Yellowknife settlement. Passenger rates are $110 one way, $175 return trip.

Types of Occurrence—Discoveries made to date in the Yellowknife area are of two main kinds: those of relatively narrow, quartz veins in which the gold is found in a "free" state or in association with various sulphide minerals; pyrite, arsenopyrite, galena, sphalerite, and in large shear zones, silicified and mineralized with sulphides. Profitable operations at present all fall into the first class.

General Geology—The Yellowknife

Valley, in which by far the greatest amount of work has been done to date, is one of a series of belts of Pre-Cambrian sedimentary and volcanic rocks which stretch northwards from the north shore of Great Slave Lake, inclosed by masses of granite and granitic rocks. At the mouth of Yellowknife Bay, the Yellowknife belt is about 7 miles in width, widening as it stretches northward and continuing, as traced thus far, for more than 100 miles up the valley of the river. In the vicinity of the bay, the sediments lie on the eastern shore; graywacke, arkose, and argillaceous rocks more or less altered, and on the western shore occur the volcanics, andesite, dacite, rhyolite and intermediate acid and basic flows. The contact lies beneath the waters of the bay. Various intrusive dikes and small masses appear in the Yellowknife Bay area, but, as far as yet ascertained, none has had any controlling influence on the ore deposition.

Gold is found, on the Con, Negus, and Giant properties, in quartz veins which occur in fractures running obliquely across the general trend of the formation, which is slightly east of north. On the Burwash property, on the west side of the bay, the strike of the vein, which was the original high-grade discovery in the field, is 13 deg. east of north. Many other veins, some of which carried gold values, which were located on the last-named property by me in 1935, strike on the same bearing, which seems to argue a certain community of origin. According to Dr. A. W. Jolliffe, of the Dominion Geological Survey, who has been engaged in reconnaissance and detailed work, with excellent results, in the Yellowknife district since its first discoveries, no apparent distinction is to be drawn between the volcanics and the sediments from the point of view of their eligibility as host rocks for the auriferous solutions.

Northwards up the Yellowknife valley conditions and types of mineralization vary greatly. Northwest of the bay, toward Walsh Lake, is the Fox group, on which a shear-zone has been exposed which is highly silicified, veinlets of quartz forming a miniature stockwork in the heavily mineralized altered country rock. Though now inactive, there is a possibility that the owners may prove up a low-grade body of large tonnage here.

The Ptarmigan—The Ptarmigan, operated by C. M. & S., lies 6 miles northeast of the settlement on the bay. Here the gold-bearing quartz veins occur in sediments, graywacke and arkose striking almost due east. Widths of quartz are greater than elsewhere in the vicinity, running to 12 ft. Recently the company acquired the adjoining Tom group of claims, seven in number, where similar veins have been discovered which carried 3-oz. ore, at one sampling, over a width of 21 ft. On the Ptarmigan, development is being carried on at a depth of 600 ft. Sufficient ore had been brought to light to make production possible this year, but the acquisition of the Tom group delayed plans for mill construction, pending the results of a diamond-drilling campaign which is under way on the Tom at the time of writing. Results obtained in this drilling and other preliminary work will have an important bearing on the location and tonnage capacity of the mill to be erected.

The "Mon" Area—No large-scale operations have been carried out in the Yellowknife valley north of the Ptarmigan. Extremely rich surface discoveries were made on the Mon group in 1937 and some underground work was done by C. M. & S., without conclusive results, and the property is deserted for the time being. Various finds have been made in the vicinity of Walsh and Upper Walsh lakes, where, towards the western granite contact, numerous acid dikes of porphyritic and granitic rocks intersect the formation. Much galena has been found in this section, occurring in small masses in quartz veins which are discolored with hematite stains. Chalcopyrite and other copper sulphides have been discovered, in shear zones near the upper end of Walsh Lake.

The Thompson-Lundmark — Eastward and north of Yellowknife, approximately 35 miles, lies the Thompson-Lundmark, discovered and staked in the summer of 1938 on the site of spectacular discoveries of free gold occurring in quartz in a knotty micaceous schist, which, inasmuch as the presence of the mica argues high temperature, has given rise to the local term "hot" sediments, used to differentiate this formation from the less highly metamorphosed graywackes and other sedimentary phases lying in the Yellowknife River belt. Two main vein systems, the "Kim" and the "Frazer," are being explored on the Thompson-Lundmark and it is said that lengths and grades are sufficiently encouraging to warrant mill installation. This group was acquired by C. M. & S. during July, 1940, and production on a 150-ton daily basis will be started in spring.

Noteworthy in the Thompson-Lundmark area and northeast again in the Pensive Lake section where many promising showings have been partially developed, is the presence of a large number of pegmatite dikes and small bosses of muscovite granite. Quartz veins are numerous and no fewer than 15 discoveries have been reported during the past two seasons. Dome Mines carried out considerable preliminary development on a property in the Pensive Lake area last season on a wide quartz vein, which did not, however, yield an average grade sufficiently high, it was stated, to warrant production now, although the company obtained a 21-year lease and further work may be done this year.

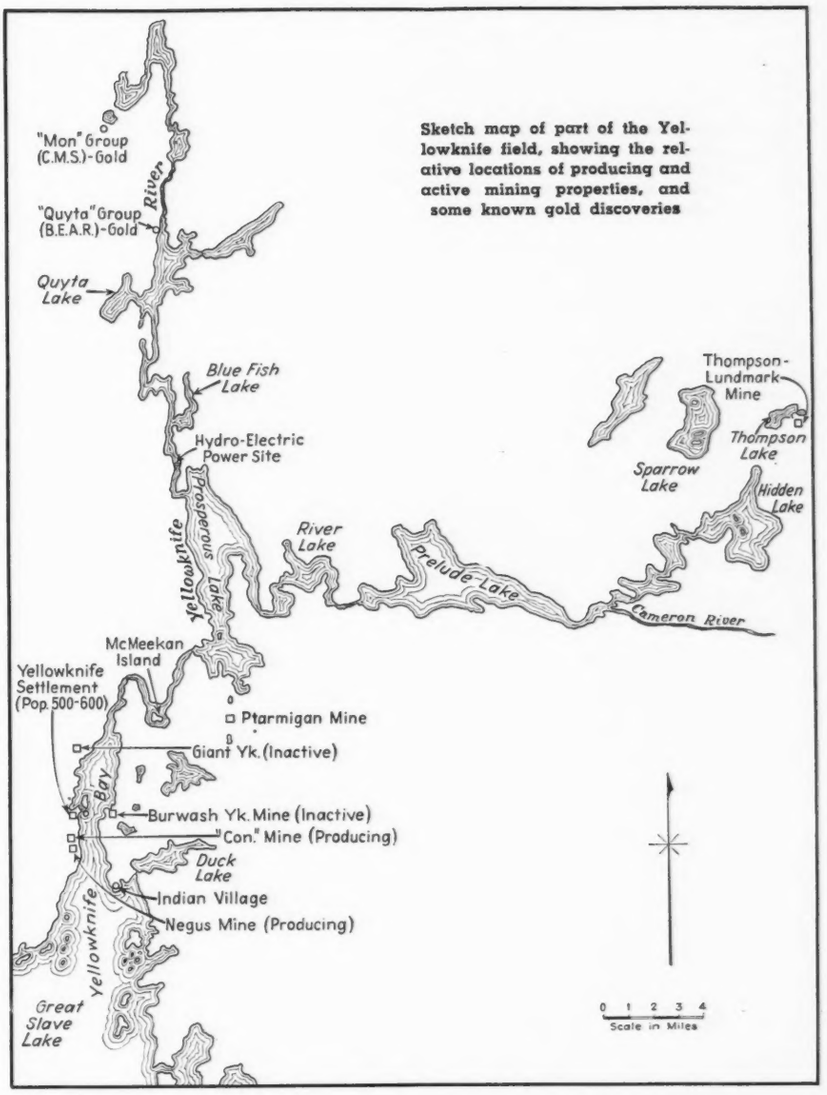
Wray Lake—Northwesterly, approximately 130 miles by air from Yellow knife Bay, lies Wray Lake on the upper waters of the Snare River, which empties, by way of Russell Lake into Great Slave Lake, near Fort Rae, on the North Arm. Territories Exploration Syndicate, a subsidiary of the Mining Corporation of Canada, sent in parties to this field in 1938, one of which, in the late summer, made a dis-

Settlement of Yellowknife, at its east end

covery of high-grade gold in the contact zone between a belt of sediments and volcanics resembling greatly the remarkably productive band of similar formation which extends from Kirkland Lake, in Ontario, eastward for more than 200 miles into the Province of Quebec. At Wray Lake, lying in a deeply eroded valley, are gossan-covered shear zones carrying in certain places rich gold values in the silicified sections which form vein systems and stockworks throughout the shearings. The nature of the discoveries led to the staking of a large number of claims in this area during the latter part of 1938, and during the past season prospectors penetrating 30 miles further northwest, discovered other promising showings 5 miles east of the Emil River, a group of claims being staked here which, it is stated, will be fully explored and sampled during the coming summer, for interests associated with Joseph Errington, of Toronto.

McDonald-Gordon Lakes—Approximately 60 miles northeast of Yellowknife excellent results attended the preliminary work carried out by Consolidated Mining & Smelting Company on the Spud group, on McDonald Lake, on showings of gold in quartz in "hot" sediments. Six miles east lies the Gordon Lake field, scene of operations of Camlaren Mines, at present inactive.

During the summer of 1940, despite the slackening of activity consequent upon the European situation, interest has centered around Slemon Lake, which lies at the head of navigation on the Slave River-Great Slave Lake water system. Two miles north and east of the falls by which the Snare



Sketch map of part of the Yellowknife field, showing the relative locations of producing and active mining properties, and some known gold discoveries

Hand drilling on the Canbrae property, Slemon Lake, Northwest Territories

River, with a drop of 70 ft., enters Slemon Lake, a discovery was made during 1939 by Roy Lundmark, who had been associated with Fred W. Thompson in the discovery of the Thompson-Lundmark the year before. Additional interest has attached to this find since then, although the original discovery conformed to the usual run of auriferous deposits in the Yellowknife area, being a fairly narrow quartz vein, and an additional discovery was made in the form of a large mineralized zone containing a stockwork of quartz veins, occurring on the contact between a graywacke formation and an intrusive of rhyolite and andesite. Spectacular free gold showed in the massive sulphides which were exposed in surface trenching. The property was taken under option by Canbrae Exploration, Ltd., a field subsidiary of Bralorne Mines, and extensive surface work done proved up a length of 260 ft. of ore running more than 1 oz. to the ton over a width of 26 in. in the first-named showing. Diamond-drilling gave five intersections which showed visible gold and cut a width of 12 ft. of quartz in one hole. Preliminary drilling of the mineralized zone did not disclose values sufficiently high to indicate the presence of an orebody, although it is not impossible that more of this work may be done there.

Adjoining the Canbrae on the south is a group of 16 claims staked by the Hoffman Syndicate, of Toronto and New York, on the strength of four gold showings found early last summer. Intensive prospecting is being carried out with a view to planning operations for the coming season.

Widespread Discoveries—It will be seen from this brief description, which by no means covers all developments in the Yellowknife area, that discoveries have been made over an exceedingly widespread territory. Traveling by commercial plane or in machines owned or chartered by their backers, prospectors have ranged, during the past four years, over an area of no less than 15,000 sq.mi. Innumerable discoveries have been made, not only of gold but of other precious metals: silver, platinum and of base

metals; copper notably and lead-zinc, and (eastwards along the north shore of Great Slave Lake) of nickel. Tungsten, in the form of wolframite, is present in gold ores on Outpost Island, on Great Slave Lake. It is reasonable to suppose that many unidentified rare metals may have been overlooked in the hasty identification which is often necessary in the field.

Use of Airplanes in Northern Prospecting—The areas which have been briefly mentioned, however, include only those which appear to be so situated as to form possible jumping-off points for further exploration. The extensive use of airplanes in prospecting is undoubtedly the cause of the far-flung activity and, in the early days of mining in any unexplored territory, this means of transportation is undoubtedly invaluable in leading to the rapid discovery of ore deposits which might not be brought to light for many years in ground exploration. However, from the point of view of the not-too-well-financed small exploration syndicate, the airplane is to be used with great caution. There is a tendency to range too far from the distribution centers, from which, in the event of large-scale development being undertaken, supplies and equipment must, as a rule, be freighted overland or by water.

Though the country under discussion is liberally dotted with lakes, there is a dearth of continuous navigable waterways; many extremely large lakes have but insignificant surface drainage outlets, much of the water apparently seeping through boulders or muskeg, and most sizable rivers and creeks in the area are rendered useless for navigation by the numerous rapids and cataracts which occur along their course. Thus, heavy freight and staple supplies must be moved, back from the main lake route, by winter tractor train; and a costly road-making program becomes necessary in the event of the terrain being unfavorable.

An Unexplored Territory—It should be understood that, before the beginning of the present mining activity, the hinterland of the north shore of Great Slave Lake lay in the centre of a district almost totally unknown to the outside world. Before 1933 only about half a dozen expeditions, beginning with the exploratory journey of Samuel Hearne in 1770, had ascended the Yellowknife Valley to the headwaters of the Coppermine River and thence crossed the divide beyond which water falls directly into the Arctic seas. Franklin, Back, and a handful of fur traders had made the trip. Pitchblende ore had been found on Cameron Bay, on Great Bear Lake, in 1930, this being the first actual rock mining to be undertaken in the whole of the spreading extent of the Northwest Territories, which has an area of 1,300,000 sq. mi., and even with the thousand-odd souls who inhabit the Yellowknife area, has today a population of only a bare 10,000 natives and whites. A wild staking boom followed the original discoveries in the Great Bear Lake field; the sole remaining recently active operation is on the scene of that discovery, at the Eldorado mine, which, too, is now closed for the duration of the war.

Eldorado, operating its own reduction plant at Port Hope, Ontario, was reported to be producing at the rate of approximately 100 grams of radium annually. This enterprise reduced the price of radium on the world's market, from $70,000 per gram to its current price of $25,000. The difficulty of surmounting the transportation problem posed by the swift-flowing Bear River, outlet of Great Bear Lake into the Mackenzie River, proved discouraging to other operators in the field. Although high-grade argentiferous deposits were found, the price of silver is not high enough to render mining of the metal profitable in such a relatively inaccessible location.

Power-plant Construction — Last spring, work was begun on a hydroelectric power project, on Bluefish Lake, at the head of a series of rapids on the Yellowknife River above Prosperous Lake, the site being approximately 20 miles from the Yellowknife Bay. This plant, when completed, will operate as a subsidiary of Consolidated Mining & Smelting Company and will supply power to the Con, Ptarmigan, Negus, and to the Thompson-Lundmark mines. It is estimated that between 4,000 and 4,500 hp. will be developed—ample for all operations at present and, if arrangements can be concluded, for the Yellowknife settlement.

Impediments to Development—With two producers working at a satisfactory profit and at least two other operations sufficiently far developed to make their entry into production almost assured, the future of the Yellowknife area as a productive mining field is bright. Factors which are impeding the rapid development of the district are the involvement of Canada in the War, this having inevitably a retarding effect upon exploration, and, a more serious impediment, the confusing Quartz Mining Regulations, which govern mining in the Northwest Territories. So detrimental have these Regulations proved to the healthy opening up of the country that but for the timely entry into production of the Con and Negus, the country would almost have reverted to its original state of emptiness, despite the known presence of so many rich showings.

Climate is Equable—In conclusion, with regard to the nature of the country, one meets with a widespread misapprehension as to the severity of the climate. The western portion of Great Slave Lake and the whole of the Mackenzie Valley, and west as far as the mountains, lies in the same zone of vegetation as does the north part of the State of Maine. The whole of this region is heavily timbered.

It is possible most years to prospect for five full months, from the beginning of May until the end of September.

Granted the survival of the producers until the end of the War, which seems to be probable, there is little doubt that the sustained interest in the area north of Great Slave Lake will lead to the bringing in of many rich mines.

Motorship "Radium Queen" on the Athabasca River

Roasting the Blue Ores of the Black Hills

A new rotary-hearth roasting furnace is developed at the plant of the Bald Mountain Mining Company, at Trojan

E. C. Brace
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IN NOVEMBER, 1936, the management of the Bald Mountain Mining Company, Trojan, S. D., decided to run some experiments on a semi-commercial or pilot-mill scale to determine the best method of treating so-called blue ore. This is a refractory sulphide ore carrying gold and silver.

The purpose of the experimental work was to determine whether a furnace could be designed and built that would show economy over other types in construction, increased recovery of gold after roasting, and simplicity of operation. After careful study it was decided to design and build a semi-commercial roasting furnace of the rotary-hearth type. The ultimate aim was to build a commercial-size furnace of upward of 100 tons' capacity per 24 hr.

Two methods of heating could be used: (1) Radiant heat by burning fuel inside of alloy metal or silicon carbide tubes, the tubes becoming red hot and radiating their heat; (2) open-flame heating. It was decided to try both. The tubes were installed first.

During the summer of 1937 the furnace was designed and installed in the pilot mill at Trojan, S. D. Operation of the roaster was started on Sept. 1, 1937, and continued on batch operations through December, 1937. Starting January, 1938, the furnace was operated steadily 24 hr. per day until **June, 1938.** Occasional short shutdowns of a few hours occurred. Both tube firing and open-flame firing were extensively tried.

As shown in Fig. 1, the experimental furnace had an annular hearth 3 ft. wide rotating between brick walls and roof. The central well was 5 ft. in diameter; the mean circumference of the hearth was approximately 30 ft.

In operation, ore is introduced through the roof to the hearth, which moves around slowly, carrying the ore until it arrives almost at the point of introduction. Here it is removed from the hearth by a large screw 18 in. in diameter, and conveyed to a receiving bin.

As the hearth rotates, the ore is continually stirred by means of plows attached to horizontal arms driven by a vertical shaft. Thus, the circular movement of the rabble plows against the slow-moving ore carried on the rotating hearth produces a satisfactory stirring, or rabbling. Observation of the ore bed shows the furrows to have a scroll appearance.

Electrical recording instruments were set to control automatically the burners, temperature, ore feed, hearth speed, rabble speed, time, unloading, and gas flow.

The furnace is divided into three zones: preheating, roasting, and cooling. With radiant-tube heating, mechanical draft is necessary for combustion of sulphur in ore and for evacuation of sulphur dioxide. Air is introduced to the ore through small ports equidistantly, arranged around the periphery of the walls of the furnace. Two larger additional air openings, 8x10 in., are in the outside and inside walls of the furnace adjacent to the ore-discharge section. In case of open-flame firing, only a stack is used to obtain draft.

The following variables were investigated, each being studied separately: temperature, hearth speed, size of ore particles, depth of ore, capacity, rabbling, introduction of air, moisture in ore, sulphur content, and cooling rate.

Results of pilot-mill tests on this blue ore showed that a temperature of 1,110 deg. F. to 1,120 deg. F. was most effective; that a variable speed hearth will readily control such factors as time of roast, capacity of furnace, and rate of cooling; that the optimum size of ore particle was 6 to 8 mesh; that the depth of charge could easily be varied; that excellent rabbling was obtained by the combined motion of the plows and hearth; that the bulk of the air for fuel combustion and ore oxidation was best introduced at the point of ore discharge, with supplementary air introduced in the roasting zone; that a moisture content of about 2.5 per cent reduced dusting to a minimum at the charging point and gave best results; and that controlled cooling is essential, with best results obtained in a thin layer of ore for 20 to 30 min.

The greater the percentage of sulphur in the ore, the longer the roasting time, and the less the consumption of gas. Ferric and ferrous sulphate, ferrous sulphide, calcium sulphate, and iron oxide are formed in the roasting process. Ferric sulphate is not detrimental, but ferrous sulphate and sulphide are cyanicides, and will foul mill solution. Calcium sulphate, if present in appreciable quantities, will clog filtration and clarifying systems, although it probably aids in increasing the settling rate throughout the mill cycle.

Comparing open-flame with radiant-tube heating, the latter is more expensive to install, but produces less dust, more direct heat on the body of the ore without flame impingement, and possibility of maintaining neutral oxidizing or reducing atmosphere. Open-flame firing is less expensive to install and is more economical in operation if no disadvantage results from products of fuel combustion coming in contact with the ore.

The data in Table I were derived from experimentation over a period of four months.

These results indicate that optimum conditions for this experimental furnace were: Capacity, 7 to 9 tons per 24 hr.; roasting temperature, 1,139 to 1,148 deg. F.; recovery, 75 to 80 per cent of the gold in a mill head carrying 0.3 oz. gold per ton.

Based on this experimentation, a commercial furnace was built with a roasting hearth area of 1,400 sq. ft. This gave the furnace a rating of 100 tons per 24 hr. The annular hearth is 12 ft. wide, traveling between outer and inner walls of 53 ft. 8 in. and 22 ft. 4 in. in diameter, respectively. The furnace is heated by open-flame burners using natural gas. All exposed metal parts within the furnace chamber are constructed of 18-8 Allegheny metal, with the exception of the rabble plows, which are made of alloy cast iron. Use of the latter material eliminated several troubles experienced with water-cooled rabbles, which tended to plug up and corrode. Furthermore, the use of plain steel or

iron in the structure resulted in considerable scaling and cracking externally, due to the heat and corrosive gases. Hence, alloy materials of construction were used wherever metal was exposed. The entire furnace is inclosed in an octagonal galvanized iron building 60 ft. in diameter.

The furnace was run from June 1, 1939, to Aug. 31, 1940, with only nominal hours of shutdown, and is continuing to function satisfactorily. Daily tonnage has varied from 75 to 125, with an average for the period of about 100. Other operating results are given in the accompanying table.

Average Roasting Data

June 1, 1939–Aug. 31, 1940

	1939	1940
Months' operation	7	8
Daily tonnage	92.84	97.50
Gold recovery from calcine, per cent	85.21	88.90
Gold content, blue ore, oz. per ton	0.417	0.340
Tailing from calcine, oz. per ton	0.061	0.038
Sulphur content, blue ore, per cent	2.71	2.57
Total sulphur in calcine, per cent	1.90	1.89
Sulphur eliminated, per cent	29.90	26.50
Sulphides in calcines, per cent	0.43	0.36
Sulphate roast ratio, per cent	77.40	81.00

The general mill practice for treating blue sulphide ore from the Two Johns mine included the following steps: primary crushing, secondary crushing, grinding to 90 per cent minus 8-mesh in a rod mill, drying to 2½ per cent moisture, roasting, and cyaniding.

The hearth speed of the roasters was one revolution in 3½ hr., zoned as follows: 1 hr. for preheating, 1 hr. for roasting, and 1½ hr. for cooling. The ore is discharged from the furnace at 572 deg. F. into a Baker cooler and is later discharged from the cooler at 100 deg. F. to a launder, where it is mixed with cyanide solution and flows to the ball mill.

To avoid the discharge of sulphur dioxide into the air, the furnace gases are sprayed in a scrubbing tower. The weak acid solution thus formed is discharged as mill effluent.

The roasted blue ore is ground in cyanide solution and then mixed with natural oxidized brown ore in the main mill cycle. In the case of Two

Table I—Effect of Heads on Recovery

Open-Flame Firing

Temperature Deg. F.	Heads, oz.	Tonnage	Bottle Recovery	Mill Recovery
Average 1,159	0.245	9.8	60.92	59.96
Average 1,146	0.388	7.83	79.62	81.10
Tube-Firing				
Average 1,121	0.226	9.5	69.50	69.93
Average 1,132	0.389	7.76	79.63	81.09

Table II—Effect of Tonnage on Recovery

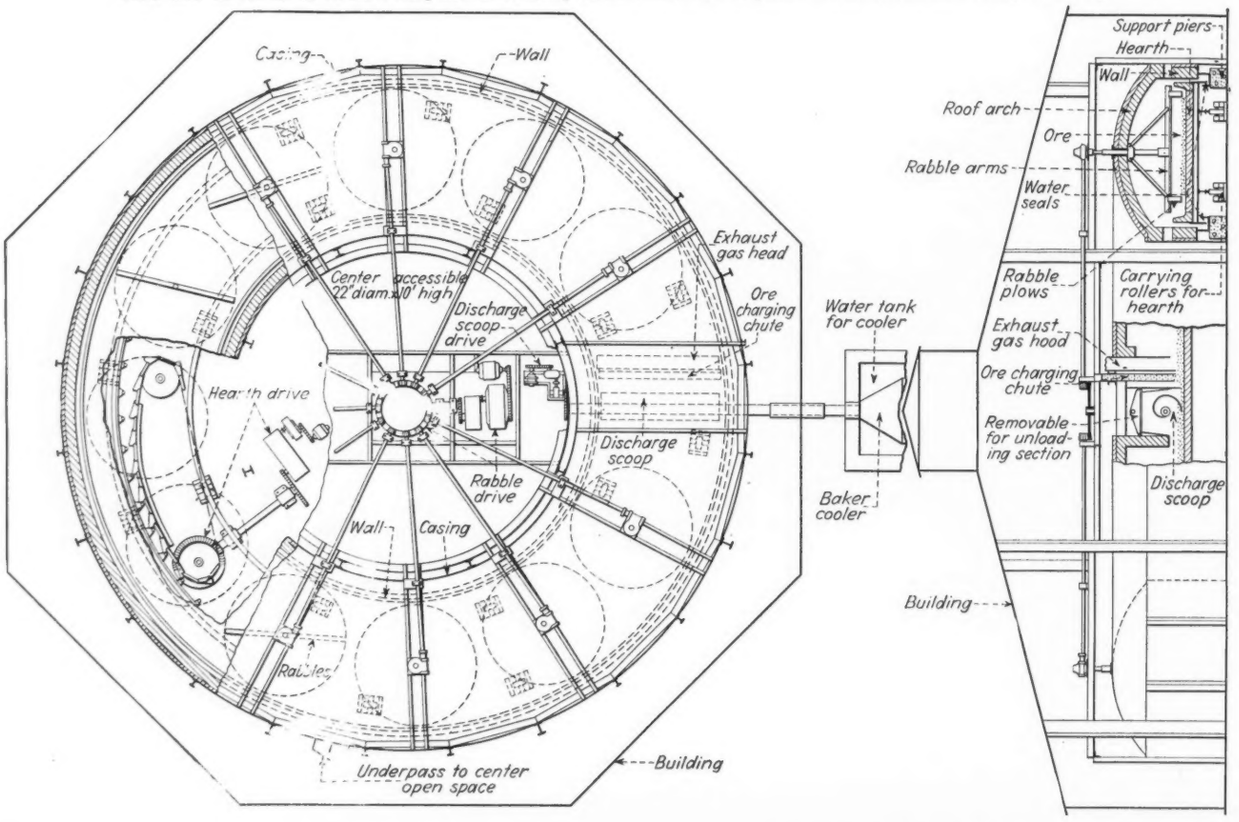
Tons Per 24 Hr.	Average Tons 24 Hr.	Average Recovery, Per Cent
5-6	5.15	82.25
6-7	6.30	82.06
	6.35	80.71
7-8	7.20	82.30
	7.45	78.23
8.0	8.25	81.95
	8.48	76.22
9-10	9.80	74.03
	9.80	72.25
	9.45	74.49
	9.37	71.54

Table III—Summary of Data Based on Percent Recovery

Open-Flame Firing

Maximum Recovery Per Cent	Maximum Temperature Deg. F.	NaCN, Lb. Per Ton	CaO Lb. Per Ton	Tons Per 24 hr.
80 plus				
Average 82.32	1,148	0.80	4.25	7.49
75-80				
Average 77.63	1,143	0.66	2.50	7.61
70-75				
Average 73.71	1,139	...	...	9.37
Average 70.97	1,155	0.66	2.76	9.80

Plan and elevation of 70-ton rotary-hearth roasting furnace installed at plant of Bald Mountain Mining Company



Johns ore, between 25 and 30 per cent admixture of calcine gives the correct mixture. The presence of calcine in the natural brown ore improves the settling rate throughout the cycle.

It will be recalled that the results of the pilot mill indicated that a minimum of 75 per cent recovery could be made on a mill head of 0.3 oz. gold per ton. It is gratifying to note from the accompanying table that after a period of fifteen months this percentage recovery has risen to approximately 90.

In general, the furnace can be said to have shown flexibility in capacity of plus or minus 25 per cent of rating, and flexibility of all controlling factors, such as hearth speed, rabble speed, cooling rate, depth of ore, time, and unloading. It has been found that a charge can be roasted if it has not been satisfactorily completed in a single cycle. This is accomplished merely by raising the unloading device, shutting off the feed, and permitting the charge to travel around the hearth again.

During the period of operation under discussion a small vein of high-grade telluride ore was opened up. This was successfully treated in small quantities with the normal grade of blue ore.

Summarizing the Trojan company's experience in roasting the blue ore of the Black Hills, we find that the particles of gold are very fine—some as small as one micron. Photomicrographs indicate that the precious metals are incased in iron sulphide. The latter must be oxidized to at least ferric sulphate, or possibly iron oxide, before the gold can be attacked by cyanide solution. The company's experience, however, indicates that the cost of obtaining a sweet roast is not warranted. Excellent recoveries are obtained if a maximum of 1.5 to 1.75 per cent total sulphur remains in the calcine of an ore originally carrying 3 per cent iron sulphide. This total sulphur content of the calcine should be composed of approximately 1.5 per cent sulphur as soluble sulphate and a maximum of 0.3 per cent sulphur as sulphide.

Variations in roasting temperature outside of the range 1,130 to 1,148 deg. F. result either in incomplete roasts that cause considerable fouling of mill solution, or over-roasting which prevents the extraction of gold and silver. A particle size of 6 to 8 mesh was found most practicable and economical. With this size particle the bed of ore can be 3 in. deep. Rabbling must be thorough up to the point of excessive dusting. Cooling must be under careful control. Too rapid cooling stops a certain amount of oxidation that continues after the ore leaves the furnace. From the company's experience I am convinced that the optimum condition for each ore should be determined by experimental treatment.

Judging from the results obtained over the past fifteen months, I believe the company has succeeded in achieving satisfactory conditions in a comparatively short time. I believe also that better recoveries from this particular blue sulphide ore can be obtained in the future.

Finally, my observations indicate that the so-called blue ores of South Dakota vary considerably in chemical and physical characteristics, and in milling properties. They differ in sulphur content, refractoriness, size of sulphide crystals, and other factors that affect treatment. Obviously, therefore, it is wise to study each ore before attempting to determine the milling requirements. For all of these reasons, experimentation with a pilot mill will always prove valuable.

At the Sliger Gold Mine

This Mother Lode property, producing 150 tons of ore per day, backfills its worked-out areas with tailings from its tabling-amalgamation-flotation plant

John B. Huttl
Assistant Editor

AN INTERESTING gold mining operation I had the privilege of visiting during my field trip to various mining districts in northern and central California early in June 1940 is the Sliger mine, operated by the Middle Fork Gold Mining Company in the extreme northwestern part of the Mother Lode near Spanish Dry Diggings in El Dorado County. The property can be reached by car over an oiled road branching off the main Auburn-Georgetown highway a short distance west of Greenwood and leading to the site of the Ruck-A-Chucky débris dam. Its discovery dates back to 1864, and during the following ten years or more mining activities carried on by different operators consisted chiefly of exploitation of small, high-grade oreshoots. When it was finally closed down, underground development had reached a depth of 300 ft. The mine remained more or less idle until 1922, when rehabilitation was started by the Sliger Gold Mining Company. Since then operations have been practically continuous.

The present company acquired control early in 1933. Improvements made both on the surface and underground in recent months have boosted daily production from an average of 85 tons to more than 150 tons. These include bringing electric power to the mine from the extensive network of the Pacific Gas & Electric Company, erection of a 75-ft. steel headframe over the new incline shaft some 1,400 ft. deep, installation of a 250-hp. Lidgerwood double-drum hoist and auxiliaries, and addition of a 5½x7-ft. Eimco ball mill to the mill flowsheet to increase grinding capacity. Preparations are now being completed to sink the main shaft another 600 ft.

The geology of the area in which the Sliger mine lies is not overly difficult. Country rocks include amphibolite, slate, and serpentine, with the latter forming a small dike. The mine is at a fault contact with black slate on the footwall and ankerite and serpentine, followed by a gabbro dike, on the hanging wall. Amphibolite schist incloses the structure. The orebodies found at different levels are believed to be the result of the ore-forming solutions rising in the past along various favorable bands in the slate series to the thrust-fault zone and subsequently spreading out, thus forming oreshoots. Width of the orebodies found in the mine varies from 14 in. to one of 30 ft., now under development and exploitation on the 1,050, 1,200, and 1,400 levels. The ore is hard and highly silicified, with some carbonates, and averages about $10 per ton. It is thickly impregnated with fine crystals of sulphides disseminated through the rock, which contain most of the gold and make up 3.7 per cent of the ore. The walls are not clearly defined, and, with a hanging wall of soft gouge, stopes require considerable timbering until backfilling is in place. Stoping lengths range from 100 to 250 ft.

Cut-and-fill stoping is practiced. The mine is one of the very few of its size that utilize mill tailings for the backfilling of worked-out areas. For this purpose a special sand-preparation plant, details of which will be described later, is being maintained at the mill. The material is brought into the mine through a standard 2-in. pipe line, with a 25-ft. rubber hose at the discharge end to facilitate distribution of the flow. Save for unions and

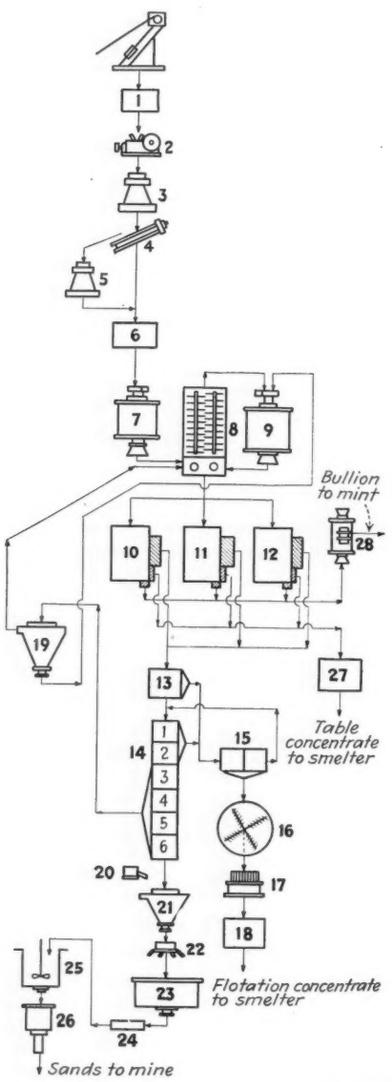
couplings, the pipe line contains no standard fittings, such as ells, tees, and others.

Underground, all dams and other stoppage arrangements in the stopes to be filled are made from 1x8-in. ship lap, cut-in drainage holes being gradually closed as the filling rises. The present plant layout permits transfer of about 140 tons of sand material at 60 per cent solids in 4½ hr. All drilling in the drifts and stopes is done with modern air drills using steel fitted with Timken detachable bits. Blasting is done with 45 per cent gelamite explosive. Because of the relatively short distances involved, ore haulage to the shaft pockets is done by hand in 20-cu.ft. end-dump cars. From these pockets the broken ore is elevated to the surface in 2-ton skips operating in the two compartments of the main shaft sunk at an angle of 62 deg.

Treatment at the Sliger mill includes tabling, amalgamation, and flotation, as indicated in this flowsheet

LEGEND

1. Coarse-ore bin
2. 10x24-in. jaw crusher
3. 4-ft. Symons cone crusher
4. Symons vibrating screen
5. 2-ft. Symons cone crusher
6. Fine-ore bin
7. 6x4½ ft. A.-C. ball mill
8. Dorr Multi-zone classifier
9. 5½x7-ft. Eimco ball mill
10. Wilfley table
11. Plat-O table
12. Plat-O table.
13. Fagergren cell
14. 6-cell Kraut rougher
15. 2-cell Kraut cleaner
16. 10-ft. Dorr thickener
17. 5-ft. Oliver filter
18. Flotation-concentrate storage bin
19. 3½-ft. cone
20. Lime feeder
21. 3½-ft. cone
22. Distributor with water jets
23. 250-ton standard cyanide tank
24. Short launder
25. Agitator
26. Feed barrel
27. Table-concentrate storage bin
28. Amalgamation barrel



The treatment broken ore receives at the mill is explained in the accompanying flowsheet. Material delivered to the storage bin at the head of the mill is crushed to ball-mill feed in three stages. The first stage involves crushing to 4 in. in a Blake-type jaw crusher, and the second to ¾ in. in a Symons cone crusher discharging onto a Symons vibrating screen with ¼-in. openings. Oversize from this unit is further reduced in a 2-ft. Symons cone crusher, and the minus ¼-in. undersize in conjunction with the crusher product goes to the fine-ore bin.

Grinding is done to 65 per cent minus 200 mesh. The equipment used for this work consists of a 6x4½-ft. Allis-Chalmers ball mill controlled by a Hardinge electrical ear, 5½x7-ft. Eimco ball mill, and a Dorr Multi-zone classifier. The latter mill operates in closed circuit with the classifier. Both mills have hydraulic traps on the discharge ends and use ball charges made up from 5-, 4-, and 3-in. steel balls. Classifier overflow at 28 per cent solids goes to three concentrating tables (one Wilfley, two Plat-O).

Gold concentrates recovered from the tables and in the hydraulic traps are treated in an amalgamation barrel. The table tailings flow to a one-cell Fagergren flotation machine, and the regular table concentrates are stored in a bin pending shipment to the smelter. Tailings from the Fagergren unit are treated in a six-cell Kraut rougher, and the concentrates and those produced by the first two cells of the rougher machine go to a two-cell Kraut cleaner. Middlings from the rougher flow to a cone, with the overflow returning to the Dorr classifier and the underflow being reground in the Eimco ball mill. Final concentrates produced by the cleaner machine are treated successively in a 10-ft. Dorr thickener and a 5-ft. Oliver filter. The sand plant at the foot of the mill receives the rougher tailings; the cleaner tailings are returned to the head of the rougher unit.

The ore treated in the mill is a quartz porphyry. The gold, of which about 40 per cent is free, is very fine. Reagents used and consumption per ton of ore treated is as follows: Reagent 404, 0.15 lb.; pine oil, 0.05 lb.; Reagent 242, 0.12 lb.; and Reagent 633, 0.05 lb. The pine oil and Reagents 242 and 404 are added at the head of the Allis-Chalmers ball mill, and Reagent 633 is added to the Fagergren cell. Ratio of concentration is 23 to 1, and total recovery about 94 per cent. The mill is currently handling 160 tons of ore a day.

Tailings from the Kraut rougher flow by gravity to a 3½-ft. desliming cone at the head of the sand plant, where lime is fed to it by means of a mechanical feeder (about 1 lb. per ton of tailings). Underflow is distributed to a 250-ton conventional cyanide tank, with a regular discharge valve at the bottom, by an eight-pipe distributor containing water jets to prepare and control the proper density of the sands. The tank serves both as storage and mixing vessel. Prepared sands withdrawn from the tank go via a short launder to a small agitator equipped with an impeller operating at 350 r.p.m. to effect further disintegration. The finished agitator product is discharged into a barrel-like container with a feed control mechanism at the bottom installed above the 2-in. pipe line leading into the mine.

Water for the camp and mill is obtained from the Georgetown Irrigation District, and electric power is furnished by the Pacific Gas & Electric Company. The compressor plant, and well-equipped machine, drill repair, and bit sharpening shops, are between the new shaft and the crushing plant. C. W. Plumb is manager, and E. H. Syms, superintendent. About 115 men are employed.

▼ ▼ ▼

Buckskin Peak Quicksilver Deposit

IN THE National mining district, Humboldt County, Nev., near the summit of Buckskin Peak, is a quicksilver deposit also bearing that name. Geological Survey Bulletin 922–E describes the general geology of this deposit and the underground workings. There are two types of ore deposits in the National district: gold silver veins that locally contain cinnabar and cinnabar-bearing siliceous sinter deposited by hot springs. The sinter, whose maximum thickness probably does not exceed 125 ft., covers an area of about 652,000 sq.ft. One type is banded and composed chiefly of opal and chalcedony that formed by direct precipitation from siliceous spring waters and the other is composed of rock fragments cemented by chalcedony and opal. The average content of quicksilver in the cinnabar-bearing zones is approximately 5 lb. to the ton.

How to Select the Crusher

Some of the features upon which a proper choice depends

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CRUSHING MACHINES are necessary items of equipment in nearly all plants used for the reduction and recovery of ores, or in the usual plant preparing sized stones for industrial uses. They are also necessary equipment in processing plants where coarse material must be reduced in size either for treatment, or for making salable products. Special crushers find other applications, such as breaking ingots and defective metal castings to a size small enough for feeding melting furnaces or processing equipment. I do not attempt to include the crushing of non-abrasive materials, since entirely different and specialized techniques are used for each of these problems.

Crushers are built, by several reputable firms, in a great variety of types and sizes, and each application calls for a specific size and type of machine, or combination of machines, for most economical operation. My purpose is to discuss the more important features upon which the choice of the proper crushing machinery must be based. It is not my intention to go into the merits of machines of different manufacture, but rather to limit this article to the general types of crushers required for various conditions. The discussion, I hope, will be helpful to operators, engineers, and students.

Any crushing problem, in its final analysis, resolves itself into the reduction of feed from a certain size to a product having a specified fineness at a predetermined tonnage rate. The physical characteristics of the material to be crushed, and its subsequent treatment, dictate the proper choice of crushing machinery.

Size of Feed—The average operation receives only moderately coarse material in its crushing plant. Where the tonnage is not great and labor is cheap, it is often economical to install a small jaw crusher with a receiving opening of sufficient size to take most of the feed, say 70 or 80 per cent. Any oversize is hand-sledged to a size small enough to feed to the crusher. For example, a plant of a capacity of, 200 tons per 8-hr. day, at a property using a mining method that would produce some 30-in. rock, would ordinarily obtain the cheapest capital layout by using a crusher having a receiving opening of approximately 24-in., such as a 24x10-in., or a 24x12-in. crusher. The small percentage of rock that is too large for the crusher opening could readily be reduced by sledges or by mud-capping to feed of crusher size.

If this same mining method were used to supply a plant of say 400 tons daily capacity, the economics of the layout would permit the installation of a 30-in. or a 36-in. jaw crusher which would eliminate the necessity for hand-sledging. In a plant treating 2,000 tons per day of this feed, it would be more economical to install a gyratory crusher of sufficient size to crush all the rock rather than to install a jaw crusher, because the latter for equal capacity at a given setting would be far too large in its receiving opening.

Inasmuch as one of the major cost items in crushing rock in small and medium-size plants is labor, the size and the capacity of the primary breaker must be calculated with this in mind. Suppose, for example, a small mine wished to crush 50 tons per 8 hr. from mine-run size to minus-1-inch. A 15x9-in. Blake-type crusher would handle this tonnage, operating continually, and would require the entire time of one man for one shift. If his wages were $5 per day, the labor cost of crushing would be 50 tons divided by $5, or 10c. per ton. However, if a single toggle crusher having an opening of 18x9 in. were used, the tonnage could be crushed in about 3½ hr., resulting in a labor cost of only 4.4c. per ton. The net saving in labor would pay the extra cost of the single toggle crusher in less than four months; the maintainance and power costs per ton would be about the same for both machines, if these were of comparable quality.

Hourly Capacity—In general, gyratory crushers have considerably more capacity in reducing to any given size than jaw crushers of equal receiving opening. Gyratory crushers have larger crushing areas, and, inasmuch as crusher capacity is a function of the rock volume passing through the crushing zone, the larger discharge areas of gyratory crushers will pass a greater volume of material in a unit of time. (Fig. 1.) However, where large pieces of blocky material are fed, the jaw crusher is often applied as a primary "sledging" breaker. Here the selection is predicated on the receiving opening, and for any rated capacity the jaw crusher always provides a far greater gape.

Secondary and tertiary crushers in larger plants are nearly always of the gyratory type, unless the final product is smaller than the product economically obtainable from these machines. In this case, crushing rolls or rod mills are also used.

Hardness of Material—The hardness of the feed may influence the construction of a crusher but not its type. For example, when crushing extremely hard material, regardless of feed size, product desired, or tonnage, it is most economical to use a specially designed jaw crusher. For example, in a plant crushing ferrochrome, in which large pieces are fed to the crusher, and a 2-in. or 3-in. product is desired, an extremely heavy steel Blake or Dodge crusher is used.

Jaw crushers can inherently be built with greater strength at reasonable cost (for capacities usually required) than the gyratory type of machine, and they possess certain other inherent advantages desirable in special applications of this nature.

Very hard, tough rock will, of course, require a crusher with heavier castings and stronger parts than a crusher used to reduce softer material.

Moisture or Stickiness—When ores are extremely sticky, due to excessive moisture or clay content, and the use of flushing water in the crusher is not permissible, it is usually impossible to use gyratory crushers, because of the probability of packing the material between the mantle and the concaves. In such a case it is necessary to use a jaw crusher, sometimes decreasing the nip angle by using special parts.

Where sticky material or clayey rock to be crushed may tend to pack in either a jaw or gyratory crusher, it is essential to wash out this constituent before crushing. Blade mills or rotary stone scrubbers are used for this purpose when the maximum size of rock is not over 18 in. With these machines the sticky or clay portion is washed out and the residue crushed in the ordinary manner.

If the feed is too coarse for a blade mill or stone scrubber, the material is fed to a large primary crusher set at a fairly wide discharge opening, so that the material can be reduced to a convenient size for washing before further reduction in secondary crushers. As an alternative a large single roll (Fairmount) crusher may be used where the rock or ore is suitable.

Subsequent Flowsheet—Though the physical characteristics outlined thus far have an important bearing on the selection of the individual machines for a crushing plant, the flowsheet following the crushing section dictates the arrangement and number of crushing machines required. Occasionally, when the characteristics of the material suggest one type of machine and the flowsheet demands another, a compromise favoring the flowsheet at the expense of most economical operation may be made. On a recent construction project for a power dam the minus-4-mesh concrete sand was made from a silica-bearing schist. From an operating standpoint, the sand could be made most cheaply in rolls or rod mills. Though the product would meet the sizing specifications, it was found that a much better particle shape was produced in a hammermill. The hammermill product made better concrete, although the silica in the schist wore the hammermill parts fast enough to result in higher maintenance expense than if rolls or rod mills had been used.

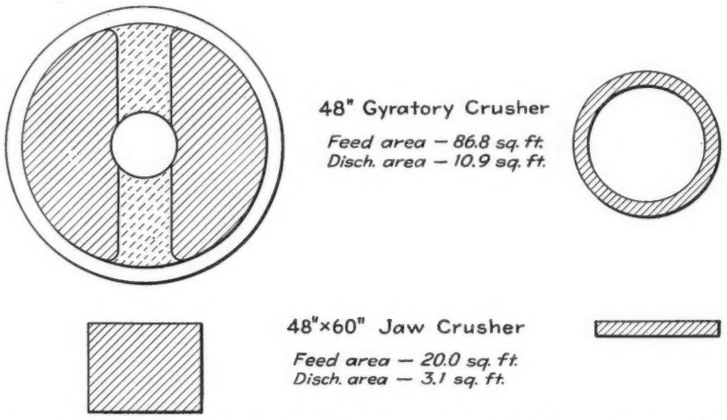


Fig. 1. . . Comparison of feed and discharge openings of a 48-in. gyratory crusher and a 48x60-in. jaw crusher

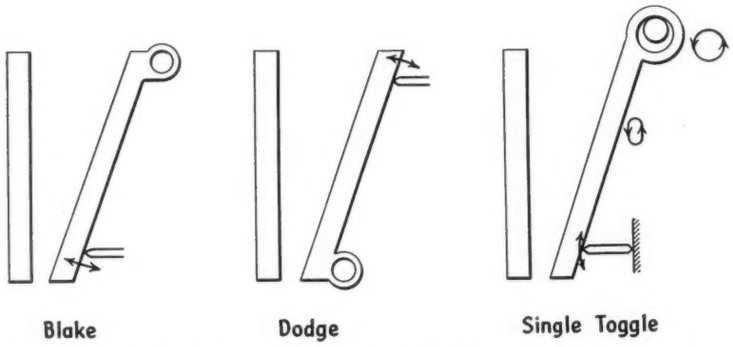


Fig. 2. . . Illustrating the jaw motions for three different types of jaw crushers

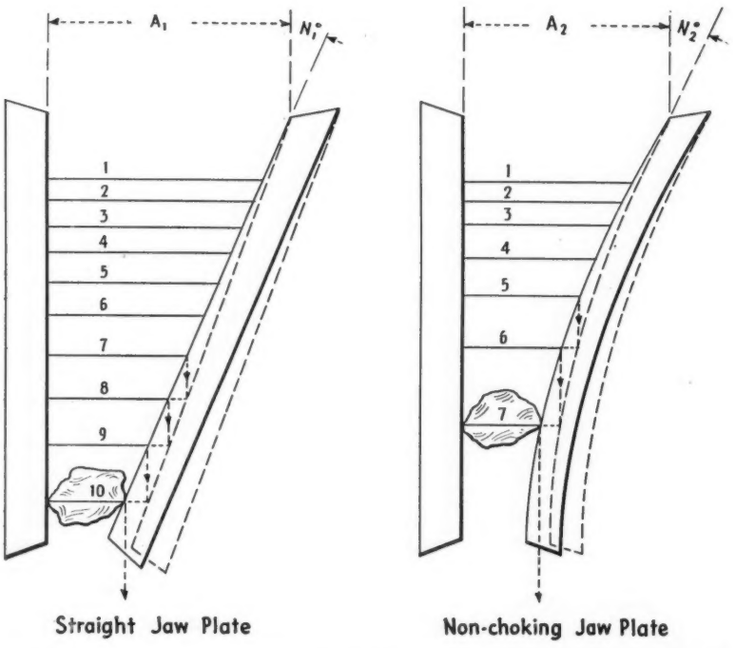


Fig. 3. . . Comparison of rock-fall through two jaw crushers, fitted with straight and non-choking swing jaw plates respectively. Solid lines show closed setting of jaw and dotted lines show jaw in open position

In mining plants requiring a fine grind ahead of flotation or cyanidation, the greatest over-all plant economy can be obtained by producing, in as few crushing stages as possible, a product with material fine enough to feed to the ball mill, and containing the maximum amount of fines. These plants are characterized as single-stage crushing (in small plants) or multiple-stage crushing with relatively high ratios of reduction in each stage (in large plants).

In other concentrating plants, where jigs and tables are used to recover the major part of the mineral values at fairly coarse mesh, it is desirable that the crushing section produce a granular product with a minimum content of fines. Jaw crushers, gyratory crushers, rolls and rod mills are commonly used in such plants, with screens to remove finished size material after each crushing stage.

Still other concentrating plants treating friable minerals, such as tungsten ores, must use multiple-stage crushing with screens in each stage selected to produce a granular product with low fines content. In these plants, the concentration must be effected as soon as the mineral is unlocked from its gangue. If the mineral is crushed finer than this, there will be an unreasonable loss from fine slimes if gravity methods are used. In treating ores of this type, jaw crushers, gyratory crushers, rolls, rod mills, and ball mills are used, with concentrating machinery operating at each stage where mineral is unlocked.

Crushed-stone plants, making a variety of sized products, require multiple-stage crushing layouts with enough screens used in the flowsheet to produce the desired sizes of products without disproportionate loss of fines. Flowsheets for these plants must be designed primarily to suit the variety of products required; the other factors are important, although secondary.

In general, it may be stated that to produce a granular material with minimum production of fines, multiple-stage crushing with moderate ratios of reduction for each stage must be used, with sizing devices between each stage to remove that part of the

crusher product which is a finished size. Where production of fines is not limited, higher ratios of reduction may be used in any crusher and the number of stages of crushing correspondingly reduced.

Primary Crushers—It is not the purpose here to discuss the mechanical details of the various crushers, as these points are amply covered by the textbooks and advertising literature. The basic differences in the action of jaw crushers of various designs are shown graphically by Fig. 2. From this it will be seen that the Blake-type crushers provide maximum movement on the smallest pieces, the Dodge crusher greatest movement on the largest pieces, and the single-toggle type a modification of the two more basic designs. Most gyratory crushers approximate the motion of the Blake design—that is, maximum movement at the discharge point of the crushing chamber.

There are, of course, certain limited fields of application for each type of machine, and consideration of the suitability of any given design for a particular problem will pay dividends in performance.

Blake-type jaw crushers have large capacity per unit length of feed opening, but as the maximum movement of the jaw is at the smallest opening, the crusher will not make a uniformly sized product. A Blake crusher, when operating on homogeneous feed with the fines (product size) removed ahead of the crusher, will crush to approximately 50 per cent minus the closed-side setting, and approximately 75 per cent minus the open-side setting of the swing jaw. These figures are predicated on the crusher operating at standard speed and eccentric throw. The minimum closed-side setting on the smallest machines is about $\frac{3}{8}$ in.

Dodge-type jaw crushers have relatively low capacities, but the products are of uniform size, averaging about 80 per cent minus the discharge setting. The inability of this design to handle appreciable tonnages has limited its application to small plants, sampling, and laboratories. Dodge crushers can be cheaply sectionalized for muleback and airplane transportation, and because of this are used in remote locations where feed is small and the tonnage moderate. Minimum practical discharge setting of Dodge crushers is about $\frac{1}{2}$ in.

Single-toggle jaw crushers (with the eccentric mounted in the top of the swing jaw) will crush rock to about 85 per cent minus the open-side setting and about 50 per cent minus the closed-side setting. The product is more uniform than a Blake crusher product and the capacity is high. These crushers are well applied in plants of average size (up to about 25 tons per hour) where they can make good ball-mill feed in one pass.

Table I—Percentage of Crusher Product Smaller Than Closed-Side Setting

	Limestone, Average Ore	Gravels, Granites	Trap Rock	Percentages Based on Open or Closed Side Setting
Jaw crushers	50%	45%	45%	Closed
Slow-speed gyratory crushers	75	70	65	Open
High-speed gyratory crushers	85	75	70	Closed
Fine-reduction gyratory crushers without spring relief	60	55	50	Closed
Fine-reduction gyratory crushers with spring relief	40	35	30	Closed
Crushing rolls in open circuit without choke feed	80	75	70	Closed

Larger plants may use them to prepare feed to secondary crushers. The only disadvantage of this design is that the rolling motion of the swing jaw results in slightly faster jaw-plate wear per ton of feed than in a Blake crusher, but if the steel wear is calculated on the basis of pounds of jaw plate worn per ton of fines made, it will approximate the wear in a Blake crusher.

Single-toggle jaw crushers have not proved practical in large sizes, because the weight of a heavy swing jaw imposes severe strains on the eccentric bearings and, to date, bearing development has not advanced to the point where reliability under this load condition is assured, without excessive cost for the bearings.

Primary gyratory crushers are used for higher capacities than can be obtained from a Blake crusher, or where it is desired to produce a granular product from a slabby feed.

High-speed or secondary gyratory crushers are used further to reduce the product of primary crushers in moderate tonnage plants and as tertiary crushers in larger plants. In some rare cases, where the initial plant feed is small enough, this type of machine may be used as a primary breaker. When dry crushing must be practiced on a feed that tends to pack in the crushing chamber, these gyratory crushers are likely to be troublesome, and rod mills or crushing rolls, operating in open or closed circuit, should be substituted as secondary and tertiary crushers.

Choice of Crushing Surfaces—The various designs of crushing surfaces lining the crushing chamber, available from crusher manufacturers' stocks, are naturally compromises of details to permit a few basic types to be applied to almost all problems. For jaw crushers (or gyratory crushers) the crushing jaw plates (or mantles and concaves) may be either straight or non-choking, and either type may be furnished with or without corrugations, although corrugated non-choking plates are rarely used. The choice of plate design for any given problem depends on size and slipperiness of feed, setting (product size), and the capacity desired.

Corrugations (vertical) on jaw plates are desirable for handling coarse, slabby, slippery feed, and reducing it to moderate size (medium to coarse crusher setting). The irregularities in the plates will tend to produce a more granular product containing more fines than a flat jaw plate operating under similar conditions, and there is less tendency for large pieces to "jump" out of the crushing chamber, the bite of the corrugations tending to hold the coarse feed in the crushing chamber until it is broken.

Non-choking jaw plates (or mantles and concaves) are used to produce a finer product from a smaller feed than can be done with straight plates, or alternatively, a greater tonnage of the same-size product.

The term "non-choking jaw plate" is an anomaly, in that the crushing chamber provided with this type of crushing surface really does have a choking point, just as any other crushing chamber. However, with non-choking surfaces this point is moved upward to a zone in the crusher where the movement between the jaws is not sufficient to cause packing and where the bulk of crushed stone is low (due to lack of void space between the few large particles). Below this zone, the contour of surfaces is such that the amount of rock-fall, for any given movement of swing jaw, steadily increases. This prevents choking and increases capacity because it permits a rapid discharge of broken material and compensates for the increased volume of rock as it is reduced in size.

The shape of the crushing surfaces also serves to present a somewhat parallel zone toward the discharge end of the crushing chamber; and, therefore, the product is more nearly uniform in size than obtained with straight crushing surfaces. Fig. 3, comparing the straight and non-choking jaw plates, shows the relative progression of material through the crushing zone. It is obvious that material will pass through a chamber fitted with non-choking crushing plates in fewer crushing strokes than when straight plates are used. The numbered lines represent the position of the rock at each crushing stroke and the relative number of crushing strokes required to crush the rock.

The advantages of non-choking crushing plates may be summarized as (1) increased capacity with a decrease in power for the production of any given tonnage, at the same setting used with a straight crushing surface;

(2) a more uniform and finer product, with resulting greater ratio of reduction, for the production of the same tonnage obtainable with straight crushing surfaces.

For many crushers, these non-choking jaw plates are made reversible. When the discharge section of the plate begins to wear because of the greater crushing work done at that point, the entire crusher plate may be reversed, substituting the bottom for the top and *vice versa*. In larger machines, the non-choking jaw plates are made in sections, so that the section of the crushing zone subjected to the greatest wear can be renewed without the necessity of changing the entire crushing surface.

When reversible non-choking plates are installed in existing crushers of older design, the size of the useful narrow dimension of receiving opening is decreased somewhat due to the lower angle of nip at the top of the crushing chamber.

Non-choking jaw plates and non-choking concaves for gyratory crushers find greatest application in secondary crushers and in moderate-size crushing plants where only one stage of reduction is used. By referring to the sketch previously mentioned, Fig. 3, it will be seen that even though the movable plate in the crushing zone is set up close, it is possible to discharge the finer crushed rock rapidly, decreasing the tendency to pack, and lowering the stresses in the machine. This makes it possible to use high speeds for crushing, so that the crusher tends to size the product at the closed setting, whereas in the slower-speed machines the sizing is always done on the open setting.

General Considerations—In ordinary applications of crushing machinery it is not economically practical to make a product finer than a nominal ¼ in. in any existing type of jaw or gyratory crusher. If finer products are desired, rolls or rod mills (a rod mill is really a multiple set of rolls) should be used, the former for reductions to about 8 to 10 mesh, and the latter to as fine as about 48 mesh. Where rod mills can be used, they possess several distinct advantages over other types of crushing machinery: They are totally inclosed and therefore dustless; wet crushing can be easily and cleanly adopted; and the cost of steel rods is much less than roll shells or gyratory parts.

In any application, the elimination of finished-size material from a crusher feed will increase capacity, reduce power, and decrease the tendency for material to pack in the crushing chamber. Grizzlies or grizzly feeders should be used for coarse separations ahead of primary crushers, and vibrating screens for elimination of fines ahead of secondary and tertiary crushers or to close a crushing circuit.

Surge bins installed ahead of primary crushers and between subsequent crushing stages will tend to even out tonnage surges and provide smoother plant operation. They should always be used where space is available, and should be of sufficient volume to accommodate all ordinary fluctuations in rock feed to the primary crusher.

Crushing Flowsheet Calculations—In calculating the sizes of crushers required to handle any given tonnage, consideration should always be given to the amount of fine (product-size) material in the crusher feed. This part of the feed, which has been broken to product size by mining or previous preparation, should bypass the crusher, as its elimination increases crusher capacity, reduces wear on the crushing surfaces, reduces power consumed, and minimizes the tendency for crushed material to pack.

The fines in the feed of a primary crusher are ordinarily removed by a stationary or mechanically actuated grizzly. Devices of this sort are reasonably efficient in scalping service down to about a ¾ in. separation. When more efficient separations are desired, heavy-duty vibrating screens or heavily built trommels may be used, but for finer separations, vibrating screens are almost universally considered most efficient and satisfactory.

Often, in the consideration of a crushing problem, it is not possible or convenient to run tests on the material in crushers of the proper size operating at the correct settings and speeds, and sizing analysis of the products are therefore not available. Without a reasonably accurate idea of the size distribution of, for example, the product of a primary crusher, it is impossible to determine with any degree of certainty the size of screen or crusher to use in the secondary and tertiary crushing circuits. Accordingly, averages of several hundred screen analyses of crusher products have been compiled, and the results are presented graphically in Figs. 4 and 5, the former representing products of primary crushers and the latter showing secondary crusher product analyses.

To use these graphs in predicting the analysis of a crusher product, the approximate effective reduction of a crusher must be known and the amount of the product that will be smaller than the closed-side setting of the machine. For example, a jaw crusher, operating at normal speed, and having a reasonable jaw movement, and with the finished size material scalped from the feed, will make a product that will be about 50 per cent minus the closed-side setting. The corresponding figures used by me for various types of crushers, averaged from

Table II—Power and Operating Labor Required for Typical Flowsheets in Crushing Plants *

Product Crushed Through In.		Rated Capacity of Plant in Tons per Hour						
		3	5	10	25	50	100	200
1½	Hp.-Hr./Ton	2.3	2.0	1.0	1.0	1.2	1.0	1.0
	Man.-Hr./Hr.	1	1	1	1	1.2	1.7	2
	Flowsheet	GR-7x10BL	GR-9x15BL	GR-9x15BL	GR-24x10ST	GR-30x18BL-SC-GYR	GR-36x24BL-SC-GYR	GR-20GYR-SC-GYR
1	Hp.-Hr./Ton	3.3	3.0	1.5	1.0	1.2	1.2	1.2
	Man-Hr./Hr.	1	1	1	1	1.2	1.8	2
	Flowsheet	GR-8x12D	GR-18x9ST	GR-18x9ST	GR-24x10ST	GR-30x18BL-SC-HSGYR	GR-36x24BL-SC-HSGYR	GR-20GYR-SC-HSGYR
¾	Hp.-Hr./Ton	5.0	3.0	1.5	1.6	1.4	1.4	1.4
	Man-Hr./Hr.	1	1	1	1	1.3	1.8	2.3
	Flowsheet	GR-18x9ST	GR-18x9ST	GR-18x9ST	GR-20x10BL-SC-HSGYR	GR-30x18BL-SC-HSGYR	GR-36x24BL-SC-HSGYR	GR-20GYR-SC-HSGYR or FRGYR
½	Hp.-Hr./Ton	5.0	3.0	2.5	1.7	1.7	1.7	1.7
	Man.-Hr./Hr.	1	1	1	1.3	1.5	2	2.5
	Flowsheet	GR-18x9ST	GR-18x9ST	GR-24x10ST	GR-20x10BL-SC-FRGYR	GR-30x18BL-SC-FRGYR	GR-36x24BL-SC-FRGYR	GR 20GYR-SC-HSGYR-SC-FRGYR
¼	Hp.-Hr./Ton	5.0	4.0	3.6	2.2	2.2	2.2	2.2
	Man-Hr./Hr.	1	1	1	1.5	1.8	2.3	2.8
	Flowsheet	GR-18x9ST	GR-20x10ST	GR-20x10BL-SC-FRGYR	GR-20x10BL-SC-FRGYR	GR-30x18BL-SC-FRGYR	GR-36x24BL-SC-HSGYR SC-FRGYR	GR-20GYR-SC-HSGYR-SC-FRGYR

Note: Hp.-Hr./Ton figures are based on installed motor horsepower for the machines in the flowsheet. Size of the primary crusher is the smallest size that will safely handle the required capacity.

*Legend: GR means grizzly, D is Dodge jaw crusher, BL is Blake jaw crusher, ST is single-toggle jaw crusher, SC is vibrating screen, FRGYR is fine reduction gyratory crusher, HSGYR is high-speed gyratory crusher fitted for a fairly coarse feed.

several operations for each machine, are given in Table I.

The percentages (based on ring size) given in Table I represent the amount of product that will be smaller than the indicated setting of the crusher, when fed with material from which the fines (product size) have been removed. Unsized feed will increase these percentages in proportion to the amount of finished material in the crusher feed. Uniformly large feed will decrease these percentages slightly, and conversely, uniformly small feed will increase the figures given.

Table II is presented to show time-proved flowsheets for the production of various size products at plant capacities up to 200 tons per hour. The equipment used is predicated not alone on first cost but with proper consideration given to operating and maintenance problems. The primary crusher in each case is of ample size for the necessary capacity, and the ratings of the secondary and tertiary stages are selected on the basis of an "average ore." The sizes of these machines will, of course, vary, depending on how the ore shatters in the primary breaker, but for estimating purposes these flowsheets may be considered reasonable. The horsepower-per-ton figures are based on the connected motor load and will serve for estimating power requirements. For very hard ores, the figures should be increased up to 50 per cent.

The "number of men" required to operate the machinery for each plant scheme does not include the labor for maintenance work. It covers only the labor to watch the feed and regulate the operation of the crushers, screens, and complementary machinery.

Initial cost of the machine should include freight and erection estimates. When this total is divided by the tons per hour of material crushed to a finished size, the resulting figures is a good basis for comparing the machines which may be applied.

Power requirements, especially in starting, are higher for crushers with heavy reciprocating parts, such as jaw crushers, than for rolls or gyratory crushers. However, for estimations of the power requirements of any given crusher, the manufacturer is usually the best source of information.

Average rock will wear away manganese steel crushing plates at the rate of about 0.02 to 0.04 lb. per ton in jaw crushers, and 0.04 to 0.08 lb. per ton in gyratory crushers and rolls. Rod-mill steel wear may be slightly higher than roll-steel wear for the same crushing duty, but the cost, due to use of cheaper steel, is considerably less.

Conclusion

In a paper of this nature it is difficult to do more than discuss the more important points which must be considered in the solution of a crushing problem. It is, however, hoped that by calling attention to some of these factors, those of us who are faced with problems of this nature will endeavor to investigate fully the various possible solutions with open minds, rather than use snap judgment that will result in costly plant delays and uneconomical operation due to poor choice of equipment. I feel that any comment or criticism that the various controversial points may elicit will aid the tendency toward more careful analysis of the problem of selecting crushing equipment.

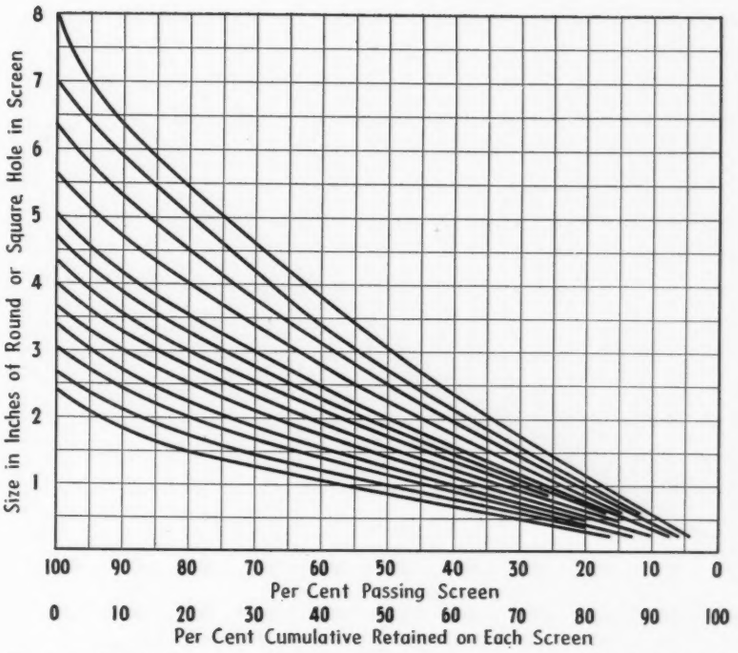


Fig. 4. . . Graph showing results of compiling averages of several hundred screen analyses of products of primary crushers

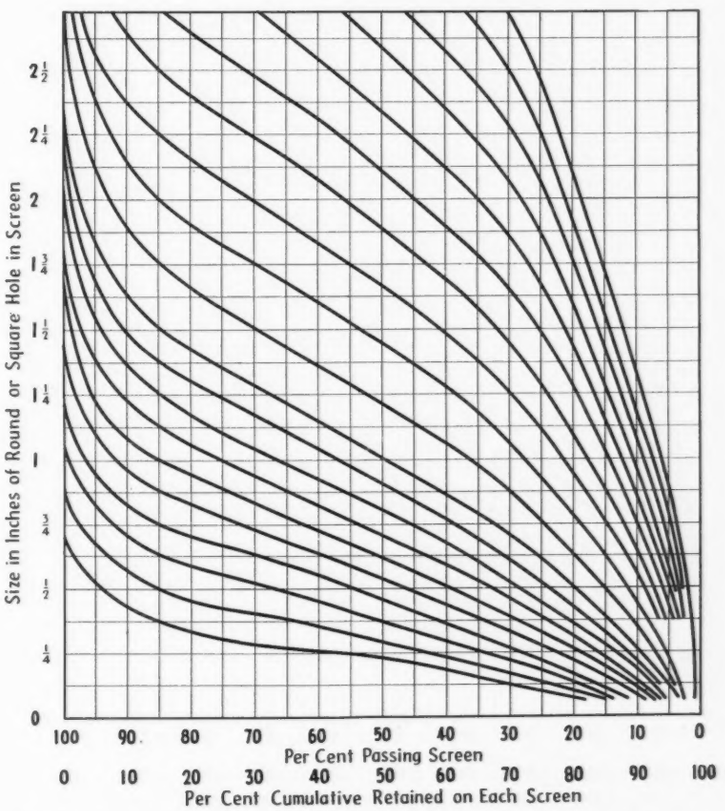
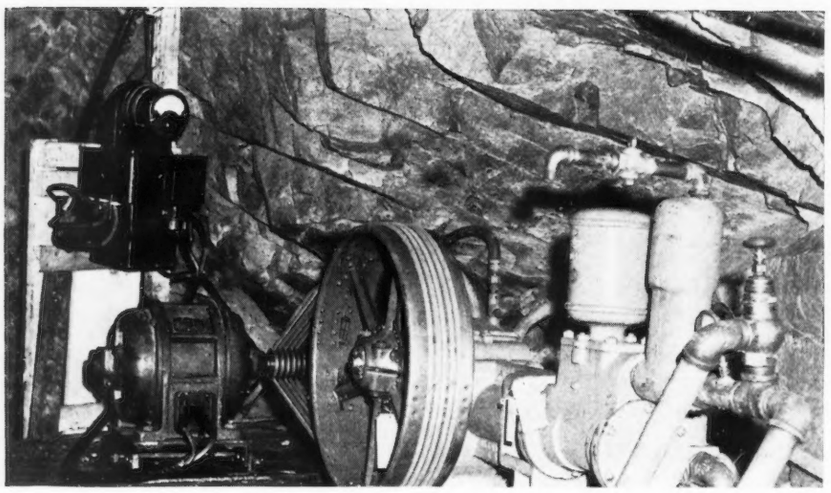


Fig. 5. . . Instead of using screen analyses of products of primary crushers to make this graph, as in Fig. 4, analyses of secondary-crusher products were used, as explained in text



The 2,300-volt power cable is shown in upper left hand corner

Determining the Power Cable for Carlton Tunnel

Types and sizes were decided on after a careful survey

S. J. Kester
General Electric Company
Denver, Colo.

THE excellent record for operation that is being made in driving the Carlton tunnel[1] at Cripple Creek, Colo., may be credited in no small part to the studies that were made to determine the most suitable types and sizes of power conductors for all services and locations in this 6-mile, hard-rock tunneling project.

Some of the major electric power applications outside the tunnel include air-compressor drives, ventilating-fan drives, and battery-charging equipment. The compressors supply air for drilling and mucking. The battery-charging equipment is used in conjunction with the battery locomotives, which make the maximum round trip of 12 miles on a single charge.

Inside the tunnel, electric power drives the pumps that furnish water to the rock drills, the ventilating booster fans, and furnishes light through transformers to many 1,000-ft. strings of lights.

A careful study showed that the cable selected would have to carry power throughout the tunnel's full 6 miles, with the voltage drop limited to a value which would leave the working voltage adequate for operation of the motor-driven equipment and the lighting system within the tunnel.

First, the size and distribution of the various electrical loads were determined and consideration was given to the load current and the limiting value of voltage drop. From the standpoint of capacity, the conductor size had to be such that the cable would not overheat under the maximum load conditions. In addition, it had to be of such a size that the voltage drop would not be excessive.

After the conductor size had been established, the type of cable most suitable for the application was decided upon by taking into consideration the local conditions under which it would have to operate. These factors were: the moisture conditions; the method of suspending the cable from the tunnel roof; the possibility of mechanical injury; and the maximum degree of safety to workmen.

The cable finally selected is of a type that has proved itself in various mine and tunnel operations in our Western mining country over a period of many years. It consists of three stranded copper conductors each insulated for 3,000 volts with a high-grade moisture-resisting rubber compound. Over each conductor a rubber-filled tape is wrapped and jute fillers are placed between the conductors to make the cable round. A rubber-filled tape is placed over this; then, a single braid; then a steel-tape protective armor, and, finally, on the outside, a cotton braid.

The steel-tape armor protects the cable from mechanical injury such as might be caused by falling rock, adds strength for suspension, and acts as a shield against electric shock to men handling or coming in contact with it. The construction is such as to give a reliable cable at minimum cost.

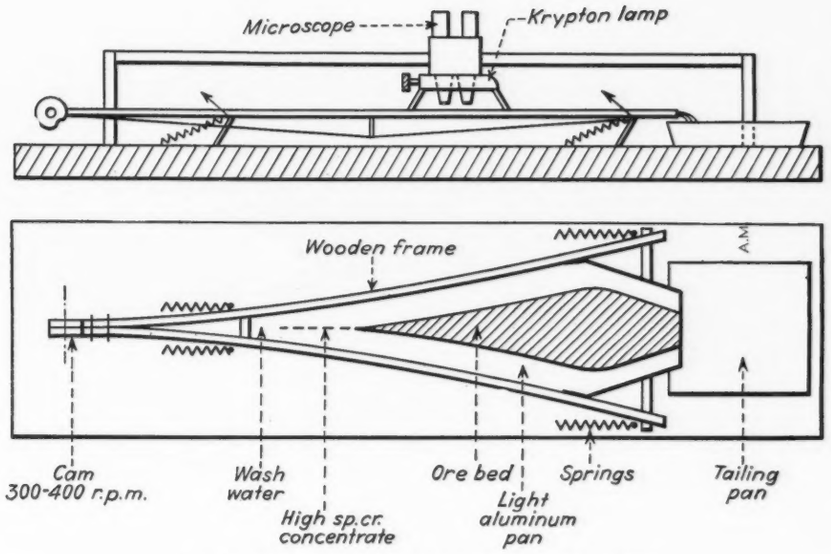
Inside the tunnel, power is transmitted over a three-conductor power cable at 2,300 volts, 3 phase, 30 cycles, for supplying the lighting system, the booster-fan equipment, and the pump which delivers water to the drills. The operating voltage of 2,300 was selected after due consideration had been given to safety, reliability, and cost of the power cable.

The various motors supplied by this power cable operate on 2,300 volts, and the lighting system operates on 110 volts supplied from 1½ kva., 2,300 to 110-volt, dry-type, step-down transformers. Each transformer handles 2,000 ft. of lighting consisting of 75-watt lamps every 100 ft. The lighting circuit of each transformer consists of two No. 10 rubber-insulated solid-copper wires having a run of 1,000 ft. on each side of the transformer.

The time taken for the preliminary survey has proved well spent. All electrical equipment has fully met the requirements for which it was designed, and has had no small part in the records which have been set in driving the tunnel. These include the world's record of 74 ft. for one day's operation, 25 ft. for a single shift, and 1,897 ft. for one month's operation.

Catenary on left below large ventilation pipe is cable at tunnel entrance

[1] *Engineering and Mining Journal*, December, 1939.



The Haultain Superpanner as modified by the authors

The Haultain Superpanner Improved

Bumping mechanism is abandoned and a direct overflow discharge is provided

Henry De Rycker
Assistant Metallurgist

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Metallurgist

PROFESSOR HAULTAIN, of the University of Toronto, described in the *Bulletin* of the Canadian Institute of Mining and Metallurgy for March, 1937, what he called his Superpanner. This ingenious machine is finding an increasing use in ore-dressing laboratories for the investigation of ores and tailings.

The machine can be considered as a mechanical gold miner's pan or as an adaptation of the Frue vanner to the treatment of small batches of ore. The ore is moved forward by a longitudinal stroke against a film of wash water; at the same time a lateral stroke keeps the bed of ore in motion and prevents channeling. The pan is shaped so that the ore bed becomes narrower as it draws forward and high specific gravity minerals collect in a narrow streak upstream while the light gangue is being washed away.

In agreement with Professor Haultain, the writers built a Superpanner in the laboratories of the University of Liége, in Belgium, and made use of it since 1938 in several ore-dressing investigations. In the course of this work, it appeared desirable to introduce some changes in the construction of the machine and the following alterations were finally made:

1. Mechanism. In the original machine, the frame was pushed backwards by a cam and, after being released, was pulled forward by a spring and bumped against an adjustable block. The machine was noisy and the adjustment was delicate, as the tension of the spring, which was not easily kept constant, controlled the intensity of the blow. Under certain conditions, a vibration arose which practically defeated the purpose of the Superpanner.

The bumping mechanism was abandoned, and, instead, a differential motion like that of a Wilfley table was imparted to the frame by a properly designed cam. The frame was kept in continuous contact with the cam by springs and its inertia was reduced to the minimum by using a light construction. The pan was made of aluminum and the frame of wood stiffened by tension springs. The rods supporting the frame were shortened to about 2 in. and given a backward inclination so as to give a lifting effect during the forward stroke as in a vibrating conveyor.

2. Discharge. In the original machine, the pan or trough was closed at both ends and the wash-water and tailing were siphoned out. Instead, a direct overflow discharge was arranged. The discharge was also slightly raised to allow for the formation of a small pool, and to prevent the ore from being washed away too quickly, particularly at the beginning of a test, the discharge was at the same time narrowed to increase somewhat the water velocity. The accompanying sketch shows the type of construction adopted.

The changes described, aside from making the machine practically noiseless, increased its efficiency so that it was possible to set longitudinal and lateral motions once for all. The only adjustments left were the slope of the pan and the flow of wash water, and this simplification was found to speed up markedly the tests.

The Superpanner was fitted with a binocular microscope sliding above the pan to make the examination of products, without removal, possible.

Working on sized feed, the Superpanner will make a separation of minerals which are very close in specific gravities and will detect very small amounts of heavy minerals in a tailing. This performance is still improved if, instead of water, the machine is fed with a heavy liquid like acetylen-tetrabromide, as was shown by a preliminary test. To take advantage of such a procedure, however, it would be necessary to make proper arrangements for preventing the operator from breathing excessive fumes of the chemicals.

▼ ▼ ▼

Truck Tires For Mine Locomotive

AMONG the equipment salvaged from the Brewster mine by the Federal Mining & Smelting Company was a battery locomotive, writes W. F. Netzeband, Joplin, Mo. The batteries were in fair condition and were recharged, but the track gage of the locomotive was 24 in., whereas the gage at the Muncie mine, where it was to be used, was only 18 in. The problem was solved by mounting the batteries on a truck chassis and replacing the gasoline power unit with a 40-hp. electric motor. The tread of the wheels is wide enough to straddle the present trackage in the mine. The truck has been used on long underground hauls, replacing mules. Carl Carmean, assistant superintendent for the Federal company, was in charge of making the change.

A Technique for Blasting With Detonating Fuse

Effective and safe procedure for quarry and open-pit work is described

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INASMUCH as some 100,000,000 lb. of explosives is used annually in quarry operations alone throughout the United States, it is apparent that the cost of explosives is an important part of the operating cost. Averaged in a general way, the cost of explosives per ton produced ranges from 8 to 15 per cent of the total and is exceeded only by the cost of labor and drilling. Although labor and drilling costs are usually fixed factors, economies in the use of explosives are frequently possible.

The method best suited to drilling an individual shot must be determined by the character of the stone, the thickness of the vein, its stratification, the type of equipment at hand, and the purpose for which the material may be later used.

The Well-Drill Method—Once piston-driven machines, mounted on tripods and operated by steam or compressed air, were used to drill holes, later to be followed by the hammer type. During that period power-loading equipment was in the experimental stage and loading was usually accomplished by hand. Thus it was expedient to drill a comparatively large number of small-diameter holes, and the depth limitation of the tripod-mounted drill made necessary the use of the bench method, whereby the face is worked in one vertical step from the rim to the floor or in a series of steps. In operations where there was a high face, a series of three or four benches was employed.

The perfecting of the power shovel made possible the drilling and shooting of larger sections of bench or several benches at a time, thereby breaking more material per shot and lessening the number of shovel moves. Some handicap, however, was experienced in that the shovel could not readily dig down to the bottom and hand labor was required to clean up material and prepare for redrilling.

As the limitations of the tripod drills became apparent, much time and money were spent in developing the churn drill. The new method permitted drilling holes the full depth of the face and eliminated the use of short benches, and the wider spacing of the holes ended the laborious and hazardous job of bench-cleaning. The resulting larger, and less frequent, blasts placed more stone on the spoil bank and therefore less shovel moving was necessary. As some of the material was not broken up as small as had been the case with the more numerous shallow holes of the tripod drill, some secondary drilling had to be undertaken with drills of the hand-held or "jackhammer" type. In some instances piston machines, mounted on short and weighted tripods, served to drill the large blocks.

However, with the development of larger crushers (both of the gyratory and the jaw types), taking stone of several tons in weight, the industry made great strides. The larger crushers contributed greatly to the success of the well-drill method of blasting. Thus the well drill, the power shovel, and the crusher all aided in coping with tasks on a scale once thought impossible.

Of primary importance in blasting is the drilling method used. When guesswork or slipshod methods are employed, only mediocre results are had and benefits are correspondingly lessened. Only when painstaking effort is expended in planning and executing the work are successful results assured. Although many factors enter into the making of a successful blast, an investigation of a blast failure almost invariably brings to light the fact of poor and improper drilling. Usually one finds, especially with well-drill holes, that the holes were not drilled to the required depth below the quarry grade line and all too frequently were too widely spaced.

Responsibility of determining the correct depth for the holes should not be left to chance or the drillers' judgment. Rather it is necessary to employ a transit to establish a series of benchmarks about the formation to furnish reliable reference points indicating the proper depth of hole for that location. By referring to these points, spotted at a safe distance from active operations, the drillers are able to avoid difficulties so often directly traceable to short holes and the resulting poor breaking of the bottom. Experience proves that more serious difficulties and delays are encountered as a result of poor bottom breakage than from improper spacing of the holes or error in estimating the explosive charge.

Spacing of Well-Drill Holes—The number and location of the drill holes will vary with the type of material, the thickness of the formation, its stratification, and the location of lines of cleavage or parting. It is best to establish a line parallel to and back from the edge of the face, along which the required number of holes, 4 to 8 in. in diameter, are drilled to the full depth of the cut and to some distance below the floor. Usually when drilling in material where good drilling footage is possible, 6-in. holes spaced 20 ft. apart give good results. However, strange as it may seem, 8-in. holes will prove more economical to drill when such materials as granite, trap, and diabase rock are encountered. An average spacing of 25 ft. generally works out best with hard stone. The measurement back from the face to the line of holes, and the measurement between the holes, of necessity must vary with the depth of the holes and the hardness of the material to be shot.

Although no hard and fast rule can be applied, one can strike a general average that will apply reasonably well. Average figures for 4-in. to 6-in. holes are suggested as follows:

Hole Depth	Burden	Spacing
20 to 40 ft.	15 ft.	12 ft.
40 to 50 ft.	18 ft.	14 ft.
50 to 90 ft.	20 ft.	17 ft.
90 ft. or over	25 ft.	20 ft.

In cases where the face averages 25

to 40 ft. in height, it is usually good practice to shoot three or four rows of holes at one time, with the holes staggered for more uniform breakage. Best results are usually dependent also on whether or not the holes are bottomed on a good line of cleavage. When the face is over 40 ft. in height, a single row of holes is recommended, because a clean vertical face is difficult to maintain and the hazard of falling ground is always present. The advantage gained with multiple rows, shot simultaneously, with detonating fuse, is that the increased volume of material broken reduces the shovel movements to a minimum and permits the use of shovels with long booms and a correspondingly wider digging and loading radius.

Depth of Drill Holes—Where benchmarks have been established indicating the exact elevation at a given point with reference to the floor, the depth of the hole required is easily established. With these measurements available and a good parting or line of cleavage present at the spring or floor line, plus careful calculating of the explosive charge required, a successful shot is assured. Depths of subdrilling required where no natural line of cleavage exists and the face averages from 30 ft. to 200 ft. in height are recommended as follows:

Height of Face	Subdrilling
30 to 40 ft.	3 ft.
40 to 60 ft.	4 ft.
60 to 90 ft.	5 ft.
90 to 100 ft.	6 ft.
100 to 125 ft.	7 ft.
125 to 150 ft.	8 ft.
150 to 175 ft.	9 ft.
175 to 200 ft.	10 ft.

Usually difficulty is experienced in keeping the face vertical and a "toe" develops that must be reckoned with when planning the shot. The greater part of the material thrown down is broken with well-drill holes fired with detonating fuse, but the toe must be thrown out by horizontal toe or snake holes, usually drilled with "jackhammer" or tripod-mounted drills. These holes are most effective when "sprung," thereby concentrating a larger charge of explosive in the bottom of the hole, where it is most effective. The toe holes must of necessity be fired at the same instant as the blast proper and this is easily accomplished by the use of detonating fuse.

Discussion in this article is confined wholly to the functions of primary drilling and blasting in accordance with the knowledge gained through experience. Both have the same ultimate objective—namely, to reduce the solid ores and rock of the formation to fragments of a size that can be handled readily by the loading shovel. Neither can accomplish this separately nor in combination with any third process. Each must function in combination with the other. Therefore, though the functions of each are separate and distinct, they are, nevertheless, wholly interdependent.

According to a time study undertaken in 1937 by the United States Bureau of Mines, tests recorded at 21 operations indicate that hammer drills as a group: (A) operate at a lower efficiency in point of time consumption than churn drills. (B) Break more rock per volume of hole than churn drills. (C) Cut a greater volume of hole per hour of drilling time than churn drills of intermediate size but less than do large drills. (D) Cut less volume of hole per hour of time than churn drills. (E) Break more rock per hour of drilling time and shift time than churn drills of intermediate size but less than large churn drills.

The study also indicates that churn drills in the group that is approximately 6 in. in diameter as compared to hammer drills: (A) Operate at slightly lower time efficiency than larger churn drills. (B) Operate at higher time efficiency than hammer mills as a group. (C) Occupy a position intermediate between hammer drills and larger churn drills, in rock broken per volume of hole drilled. (D) Drill greater volume of hole than hammer drills during shift time, and less than larger churn drills. (E) Produce less material per hour than hammer drills or larger churn drills.

Estimating the Charge—It is good practice to estimate the cubic yards or tons of material in the area blocked out for blasting by allowing a factor of 1 lb. of explosive to every 3 to 6 tons of material. Where the holes are deep and the material varies somewhat in hardness or toughness, or is weakened by seams, the charge is most effectively loaded in broken sections or "decks" and frequently with several grades of explosives. This is accomplished by filling in the intervening voids with tamping material. Such a charge can be successfully detonated by inserting at least two electric caps in each section of explosives. The better method, however, is to drop a line of Cordeau or Primacord to the bottom of the hole, thereby avoiding a multiplicity of wires and the attending difficulty of keeping them paired and intact, and of equal importance is the fact that premature explosion hazards occasioned by lightning or sneak currents are prevented.

Cordeau consists of a small lead tube of about the same diameter as double-taped fuse, filled with T.N.T. which has a velocity of 17,500 ft. per second. The extreme violence with which it explodes is sufficient to detonate high explosives lying adjacent to it in a borehole and, therefore, the charge detonates instantly throughout its entire length. In spite of its great velocity and the strength of the detonation, Cordeau is very insensitive to shock and cannot be detonated by hammering, pinching, or burning. In actual use in the field, it is detonated by a common or electrical blasting cap which must be in actual contact with the T.N.T. core of the Cordeau. Thus one enjoys considerable added safety while engaged in loading and tamping a blast, since not until every detail is completed and all persons are safely removed from the scene is the essential detonating cap affixed to the main lines.

Primacord is the successor to Cordeau and has numerous distinct advantages that make it readily adaptable to a multiplicity of uses heretofore considered impossible of accomplishment. It has the distinction of having none of the disadvantages and several noteworthy improvements over Cordeau.

The T.N.T. core of Cordeau is replaced in Primacord with an explosive known as P.E.T.N. The rate of detonation of Primacord is approximately 21,000 ft. per second, compared to 17,500 ft. per second for Cordeau. The high velocity of Primacord (practically instantaneous) insures complete detonation of the explosive charge in the drill hole. The use of it eliminates the chance of missed holes caused by

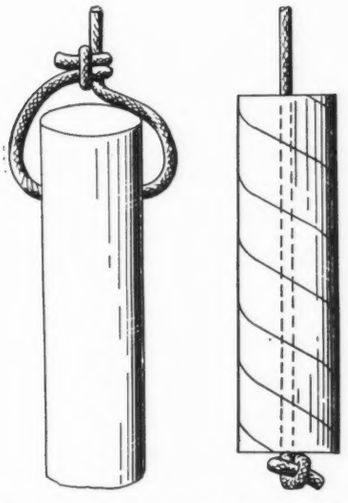


Fig. 1 . . . Two ways of lacing the initial cartridge in loading a hole

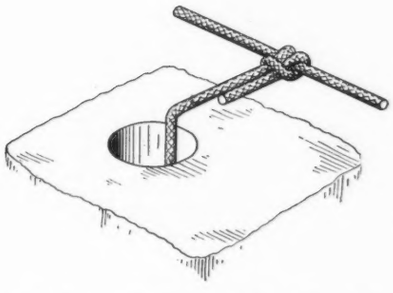


Fig. 2 . . . In connecting a branch line of detonating fuse to the main line, as seen here, a half hitch is used

failure of the explosive charge to propagate through dead spaces which may be caused by crimped paper ends of cartridges or the presence of tamping material between cartridges. Any or all of these conditions may contribute to a distinct lessening of force and speed in the explosive wave until propagation no longer is possible and hole stubs are later discovered loaded with explosives.

Use of spliced lengths of detonating fuse in drill holes is not recommended. In wet holes the water pressure may be sufficient to penetrate the two ends of the lap, which may cause failure. Also, the dropping of explosive cartridges down the hole might strike and injure the wrapped connection.

The initial stick of powder is pierced lengthwise with a skewer, (bronze or wood) and the end of the Primacord is passed through and formed into a knot (Fig. 1). Then the powder is lowered to the bottom and the fuse is pulled taut along one side of the borehole to prevent it from being struck by the subsequent loading and tamping operations. Only sufficient length should be cut from the spool to make attachment to the main run convenient, and the end is best secured by placing a stone on it or by tying it to a short stake.

Settling

Once the hole is loaded and tamped the end of the Primacord must be freed, unless the blast is a small one and will be fired immediately, for in large blasts that may consume days in loading the charge and tamping both tend to settle and may easily cause the fuse to part unless free to move. Sprung or chambered holes usually give the most trouble by settling.

Once the loading is completed, the final work of connecting up the blast is undertaken by laying the main lines that will be connected to the branch lines protruding from the holes (Fig. 2). A little cleaning up is usually necessary prior to this operation, for the empty cases and other debris scattered helter-skelter tend to make walking difficult and result in breaking the fuse. At this point it is important that the first row of holes should be connected to that section of main fuse which will receive the detonating cap, in order to insure these holes firing a split second ahead of the remainder of the shot.

Though each shot differs from others in some degree, the diagrams in Fig. 3 will indicate a type of hook-up that can be applied with good results.

The P.E.T.N. core absorbs water very slowly, and as only the cut end of the Primacord is exposed, any difficulty that might arise due to wet weather is minimized. It is well to guard against excessive moisture, however.

When all laterals are properly connected and *counted* to insure none having been overlooked, the final job of affixing the detonator is undertaken (Fig. 4). Be sure that end of the Primacord is freshly and squarely cut off to insure it being dry and undamaged. This also applies to the time fuse if that type of initiating agent is used. Next a straight union is attached to the detonating fuse by crimping the end opposite the slit end so that the end of the fuse comes up to the small hole at the end of the slit. Then insert the cap in the slit end of the union until it comes up snugly against the fuse. This can be seen through the small hole. Then slide the ring on the union over the cap to hold it firmly in place.

Current Leakage — Inasmuch as there is no such thing as a perfectly insulated blast, we must recognize the fact that faulty insulation, in common with several other factors, is the underlying cause for various mystifying electrical blast failures. The principal one of these is the failure of center shots to fire when using the series circuit. In using this method each extra detonator added to the series increases the ohmic (electrical) resistance, and thereby requires that a compensating rise in current pressure is necessary to force the requisite amperage through the series. This rise in potential, however, often defeats its own purpose by reason of the fact that it frequently causes insulation failures through which much of the current bypasses around the detonators. The bypassing occurs in this manner: As the current enters the series a small portion of it leaves the wires of the first drill hole through the various defects in the insulation. At the second hole additional current leakage occurs and a like situation occurs at the third hole. This bypassed current is meanwhile traveling through the various conducting elements adjacent to the boreholes, such as water, earth, clay, or mineralized stone. By this means much of the firing current is no longer available to fire the center detonators by heating the bridge wires. However, as all current leaving one terminal of a generator must return to the other terminal, the bypassing current seeks a return path to the generator, and therefore begins to reenter the shot circuit through the leg wires nearest the negative or point of exit end.

Why in so many cases only the center holes fail to fire in series circuit thus becomes evident, the cause being, of course, that only the detonators nearest each end received the required amperage to explode them. In other instances, the misfired detonators are found scattered at random in the circuit. Usually this is due to the fact that only these detonators were bypassed by the shot-firing current through their faulty insulation or slightly higher than normal resistance in the bridge wire.

Limitations of 25-Cycle Current—A fact worthy of mention here is the difficulty encountered in blasting series circuits with 25-cycle current. The resulting misfires compare favorably with the sporadic misses noted in the misfired series circuits caused by insulation breakdowns. The explanation lies in the fact that no detonator can fire in less than 0.014 seconds. Although detonators may on occasion require a slightly longer period, they do not fire in less than 0.014 seconds.

The current wave produced by a 25-cycle generator makes approximately 0.7 of the complete alternation in the minimum time of firing a cap, so that actually the full heating effect is applied at least once during the alternation. Thus theoretically the 25-cycle current should fire any reasonable number of caps in series provided the proper potential is maintained to force the required 2 amp. through the series. Nevertheless, occasionally some detonators fail to fire even though the insulation values remain high. The explanation offered by electrical engineering authorities is that the misses that occur are due to the fact that occasionally the current is applied to the circuit just as the reversal of the sine wave takes place. Be that as it may, the fact remains that misses do occur with 25-cycle current and do not occur when 60-cycle current is substituted, all other factors remaining equal.

Spacing

Loading Factors—Experience is the only reliable guide for determining the proper distance for spacing holes on any particular bench. When a bench is started, the holes are generally spaced closely together to insure proper breaking of the rock; then the distance is gradually increased until the space gives the maximum efficiency of drilling and blasting is found.

When steam shovels are used, it is the constant aim so to drill the holes and blast the rock that the toe is not thrown out on the track or the steam shovels; that no hard bottom is left; and that a minimum of boulders is made. The banks must be so broken that no dangerous overhangs of rock and no serious back or overbreak occur to interfere with drilling for the next shot.

The physical properties of the material to be blasted are of fundamental importance in determining the correct explosive and manner of blasting. Careful observation and study are needed to make the proper selection. However, after an explosive has been selected, difference of opinion may develop regarding the merits of that grade. These differences often resolve into certain specific operation or

safety problems. For example, the work an explosive does is influenced to some degree by some or all of the following factors: (1) diameter of cartridge; (2) loading procedure; (3) drill-hole diameter; (4) tamping and stemming; (5) cushioning or "deck" loading; (6) method of priming.

Cartridges larger than the basic 1¼x8-in. size permit concentration of more charge at the back of the hole, stand up better under long storage, and are more sensitive. Numerous tests show that velocity of all explosives increases when diameter of cartridges is enlarged and also when confined. This rate of increase depends upon the grade, and all grades do not show the same rate of increase.

When cartridges are slit and tamped they shoot differently than when loaded intact. The slit cartridge, in effect, is increased in diameter and confinement, so that when the same explosive is used in the same mine, but loaded differently, it often produces spoil which looks as if it was shot with two different grades.

Varying diameter of hole will effect blasting, because, if depth is constant, the volume varies as the square of the diameter. As a result a cartridge in too large a hole has an air space between it and the ore and the effect of the blast is cushioned and the confinement lessened, decreasing the velocity of the charge. Tamping bags too small in diameter and too long telescope or collapse when tamped, so that only 4 or 5 in. of the hole is compacted and the remainder is practically untamped, with unintentional cushioning and improper confinement of the charge. Proper stemming is of great importance. It decreases the quantity of explosive needed, keeps fumes to a minimum, and produces better fragmentation.

Safety First

That a little knowledge "is a dangerous thing" is nowhere more true than in the explosive field, wherein inadequate data and rule-of-thumb methods may easily involve a serious potential hazard for persons and property. Though explosives engineering, as practiced, is not "an exact science," its relatively few fundamental scientific principles arrived at deductively by experimental data over a period of years do merit study and application, regardless of one's opinion as to whether or not blasting is an art or a science.

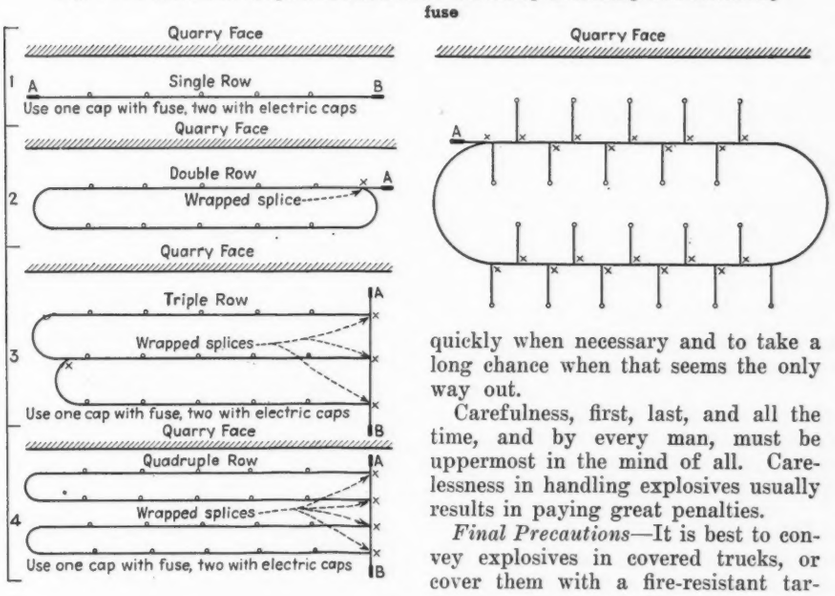
To conduct blasting operations successfully and efficiently requires a combination of caution, patience, and care, coupled with a willingness to decide quickly when necessary and to take a long chance when that seems the only way out.

Carefulness, first, last, and all the time, and by every man, must be uppermost in the mind of all. Carelessness in handling explosives usually results in paying great penalties.

Final Precautions—It is best to convey explosives in covered trucks, or cover them with a fire-resistant tarpaulin in open trucks or rail cars or when on the ground. High explosives and detonators should always be transported separately, handled carefully, and not subjected to rough handling or abuse. All explosivess and detonators should be protected from fire, direct summer sun rays, and sparks or flame, as well as exposure to moisture. Wires of electric detonators should be kept short-circuited and free from contact with rails, pipe lines, or power cables, as these may be electrically charged with a potential sufficiently high to fire the detonator.

Finally, "make haste slowly," as the saying goes, and leave no detail undone or taken for granted. Remember, the blasting crew is no safer than its most careless man.

Fig. 3 . . . Various hook-ups that can be used effectively in blasting with detonating fuse



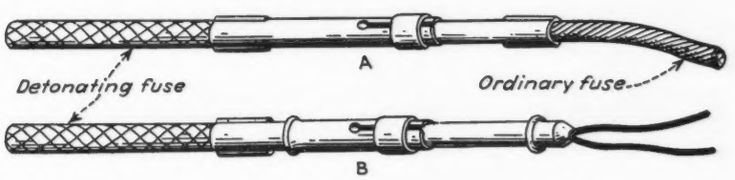


Fig. 4 . . . Affixing the detonating cap to the detonating fuse. *A*, Blasting cap with its ordinary fuse connected with the detonating fuse by a straight union. *B*, Electric blasting cap connected with the detonating fuse by means of a special union

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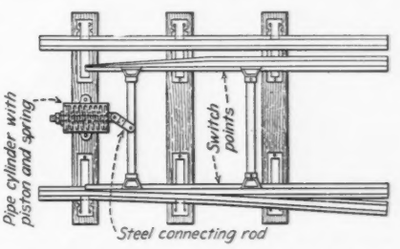
Locking Switch for Inclined Plane

THE switch-locking device shown in the sketch has given good service at a gold-silver mine in central Mexico, where part of the ore production and supplies were handled over an inclined plane with three rails above and two below the parting. As known, in such an installation it is often difficult for the man at the drum to see the parting point, so that he must trust to luck to land his trip safely. Although only the most dependable men were employed here, wrecks frequently occurred at the switch points, causing delay and damage. The answer was to provide each switch with an automatic locking device, possibly one operated by mechanical means rather than by electricity. Accordingly, the mechanical department worked out the arrangement shown. It is simple, and also positive in action. Parts required include a small cylinder made from



steel pipe, a piston-like rod with a steel spring, both operating in the cylinder, and a short lever or fork to connect the piston end to the switch bar. The device acts to hold the switch point close to the rail, no matter how the switch may be set. Each downcoming car automatically sets the switch for its own track and the spring practically locks the points in position, thus insuring safe delivery over the proper track to the head of the incline.

One-Man Diamond Drill Proves Worth at Jardine

Data for approximately 5400 ft. of hole demonstrate the costs and efficiency obtained

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Jardine, Mont.

PRIOR TO 1939 only six diamond-drill holes had been drilled at the Jardine mine, at Jardine, Mont., and they had been located to cover only a very small area of the general mine workings. Little information is now on hand respecting this earlier work. On Jan. 18, 1939, however, drilling was begun with a No. 6 One-Man Sullivan diamond-core drill, this equipment and its capacity being quite different from that previously used. Encouraging results have been obtained, both geologically and economically, and it is thought that the data here presented respecting the costs obtained and the efficiency of the work will be found interesting.

At the outset, after a man had been trained in running the new drill for a few days by an experienced operator, drilling was conducted with but one man per shift. For several months two shifts per day were worked, but this was stopped after it was realized that the drill was locating more new bodies of ore than could be followed up directly with development work.

The position of each hole was first determined by the engineering and geological staff and approved by the foreman and manager so that the best results could be obtained. The relatively short distances possible to drill with the equipment provided have made it necessary to choose prospective ore zones which could be undoubtedly reached not only with the drill but with subsequent raises, crosscuts, or drifts from present workings. Where large blocks of virgin ground existed between present and past productive areas, an attempt has been made, with varying success, to locate the extensions of known orebodies and determine their worth. Most of the holes drilled have been for the purpose of locating new orebodies which lie out of bounds of present and past workings.

Although the manufacturers had claimed a capacity of 250 ft. of hole per day for the machine, it was soon found that the drill could do better than this by over 100 ft., with careful handling. A $\frac{7}{8}$-in. core was taken in 5-ft. runs, drilling a $1\frac{1}{4}$-in. diameter hole. The sludge containing the cuttings was pumped back continuously from the bottom of the hole and caught in containers for settling.

As complete data as facilities and time would allow have been kept on the diamond-drill costs and disclosures. Each bit of core has been logged geologically. Wherever sludge samples or physical appearances warranted it, the core has been split in half and one half sent to be assayed as a check against the sludge sample for the corresponding location. The remaining half of the core is kept in racks for more thorough examination in the future. Sludge samples are caught for each consecutive 5 ft. of drilling. Due allowances were made for loss of core where the recovered part sampled well. Salting of sludges by caving holes or by other means was also given consideration in order that the true results could be obtained.

Each drill operator reported footage drilled, time lost, and reasons for time lost daily. Diamond-drilling costs, distribution and cost per foot of hole drilled have been calculated each month by the mine office staff.

Thirty-three holes have been completed to date. The average length per hole drilled is 163.4 ft. In all, 5,393 ft. of diamond drilling was done. Of that total, 666 ft. of vein material was cut altogether, or, figured in percentage, 12.35 per cent of the total distance drilled was in vein matter.

Thanks are due R. E. Gilbert and E. J. Schweffel for helping to gather the data for this report, of which the information here given is a part.

Diamond-Drilling Costs per Month at Jardine

Month	Aver. Cost Per Ft.	Total Cost	Operating Labor; Repairs	Supervision Including Sampling	Supplies, Bits, Oil	Power: Compressed Air	Assay Office
Jan. '39	$1.15	$178.83	$54.64	$40.00	$46.17	$14.01	$24.01
Feb. '39	1.13	571.30	212.60	40.00	272.48	15.01	31.21
Mar. '39	0.754	113.76	83.59	10.00	5.38	6.48	8.31
Apr. '39	0.897	282.84	87.31	40.00	118.41	15.80	21.32
May '39	0.638	461.38	184.92	40.00	203.55	14.82	18.09
June '39	1.10	517.72	241.53	40.00	204.06	16.50	15.63
July '39	0.79	404.56	208.98	40.00	120.84	10.67	24.07
Aug. '39	0.82	246.14	125.97	40.00	47.04	14.79	18.34
Sept. '39	0.902	590.85	241.61	40.00	279.76	12.20	17.28
Oct. '39	0.869	400.47	131.82	40.00	191.44	12.69	24.52
Nov. '39	1.05	278.64	117.10	40.00	90.94	15.37	15.23
Dec. '39	1.27	349.89	120.88	40.00	141.03	25.76	22.22
Jan. '40	1.24	281.64	110.42	40.00	87.18	24.85	19.19
Feb. '40	0.894	291.38	120.13	40.00	86.00	20.94	24.31
Total	$13.504	$4,969.40	$2,041.50	$530.00	$1,894.28	$219.89	$283.73
Average	0.921	354.96	145.82	37.85	145.82	15.71	20.26

Diamond-Drilling Efficiency Results at Jardine

Hole No.	Feet Drilled: Per Working Hour	Feet Drilled: Per Drilling Hour	Total Feet Drilled	Cost Per Ft. Average	Feet of Vein Material Cut	Feet of Barren Rock Cut
1	0.71	1.05	31	$1.15	20	11
2	1.76	2.59	113	1.15	5	108
3	1.83	2.53	147	1.13	10	137
4	1.55	2.42	143	1.13	7	136
5	1.36	1.93	365.5	0.98	114	251.5
6	2.02	2.38	300	0.897	14	286
7	2.08	2.65	150	0.749	45	105
8	2.21	2.35	283	0.638	46	237
9	2.85	4.10	160	0.638	24	136
10	3.20	3.66	205	0.638	20	185
11	2.38	2.51	372	1.10	43	329
12	1.41	2.08	102	1.10	16	86
13	2.67	3.07	120	0.79	6	114
14	2.38	2.90	171	0.79	0	171
15	1.37	1.80	263	0.80	13	250
16	1.18	3.30	33	0.82	2	31
17	2.32	3.25	130	0.82	17	113
18	1.70	2.25	150	0.85	3	147
19	2.08	2.43	150	0.902	65	85
20	3.25	3.94	130	0.902	19	111
21	3.11	3.61	112	0.902	1	111
22	2.92	3.75	105	0.902	16	89
23	2.59	3.05	85.5	0.902	3	82.5
24	0.92	1.25	17.5	0.902	12	5.5
25	2.56	3.50	133	0.869	22	111
26	2.44	3.90	78	0.869	18	60
27	2.93	3.44	141	0.869	50	91
28	2.06	2.87	66	0.869	17	49
29	1.30	1.56	308	1.024	3	305
30	2.40	2.85	365	1.26	1	364
31	1.98	2.13	166.5	0.894	13	153.5
32	2.77	3.12	50	0.894	1	49
33	2.06	2.27	247	0.894	20	227
Totals	70.35	90.49	5,393	$30.024	666	4,727
Average	2.13′	2.74′	163.4′	$0.921	.....	.....

Average number of feet drilled per working shift, 15.78
Average number of feet drilled per drilling shift, 24.74

PHOSPHATE
The Vital Non-Metallic

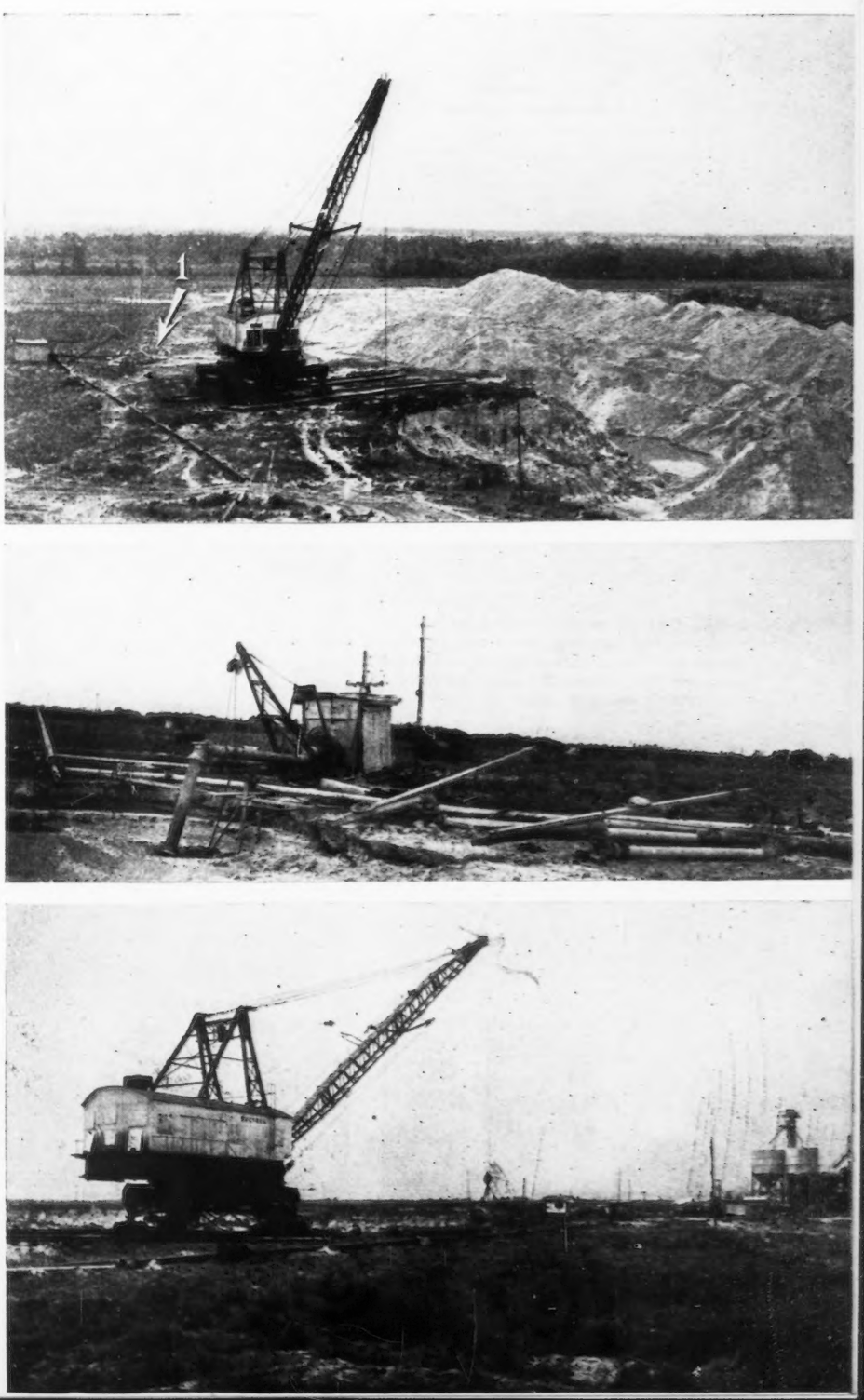
IV—The account of the tour of the Florida pebble field is here completed . . . Operations of the Phosphate Mining Company, the Coronet Phosphate Company, and Swift & Company Fertilizer Works

A. H. Hubbell
Associate Editor

▶ PRECEDING INSTALLMENTS, *in the September, October, and November issues, respectively, have dealt with the activities of International Agricultural Corporation, American Cyanamid Company, Southern Phosphate Corporation, and the American Agricultural Chemical Company, in the order named. No attempt has been made to present detailed descriptions of these operations, but sketches of them instead have been given as they would be seen by a visitor, with emphasis on the high lights. In the current issue the account of the trip through the pebble field is completed.*

Next month the scene of the story will change to the phosphate-producing area of south-central Tennessee, the other important division of the southeastern phosphate field of the United States.

THE WEEK-END is an awkward time for attempting to visit any mine or plant, for obvious reasons. However, when I approached the offices of The Phosphate Mining Company, at Nichols, on a Saturday morning, under the impulse of a crowded schedule, I was accorded a most friendly reception by E. T. Casler, the chemical superintendent. J. T. Bullwinkel, president of the company, to whom I am indebted for permission to see something of the Florida operations, makes his headquarters in New York. The company is managed locally by T. J. Hanley, comptroller, and Mr. Casler, chemical superintendent, and G. R. Barber, operating superintendent.



At No. 43 mine of The Phosphate Mining Co. at Nichols. At the top is seen the dragline which digs the matrix and drops it into a sump dug in the surface at (1), where it is disintegrated by hydraulic guns and picked up by the pit-car pump suction and sent to the washer. A close-up of this sump with the pump and guns is seen in the middle picture and, in the one at the bottom, another view of the dragline, with the washing plant in the distance

The company, which has been mining phosphate for almost 35 years, was operating its own power plant, two mines and washers, a drying plant, a grinding plant, and a calcining plant. A flotation plant is under construction.

In addition, the company has a chemical plant which is equipped with a large electric furnace producing phosphorus. From the phosphorus, phosphoric acid of food-grade quality is made, and at present it is also used to manufacture triple superphosphate, which is sold under the trade name of "Electrophos." This is the only electric furnace for the production of phosphorus in Florida and south of Anniston, Ala. The chemical plant, which is at Nichols, runs continuously seven days a week. It has been engaged in the activities mentioned about one and a half years and has been operating at capacity. The company is now building a contact sulphuric acid plant and a new phosphoric acid plant which will produce a larger tonnage than its present plant. This phosphoric acid will be used for triple superphosphate and other fertilizer phosphate chemicals.

Nichols is a company-owned village in which all of the company's operations except the mines and washers are situated, including houses for company employees.

The Nichols mines, preferably called No. 43, are running one shift with a washer capacity of 1,000 to 1,500 tons per eight hours. The Phosmico, or No. 91, mine is near Bartow, and its washer capacity is half this tonnage. The production of No. 91 mine will be augmented with the output of the new flotation plant. There is a separate drying plant at Phosmico, which is used to dry the Phosmico tonnage. No. 43 rock is dried in Nichols.

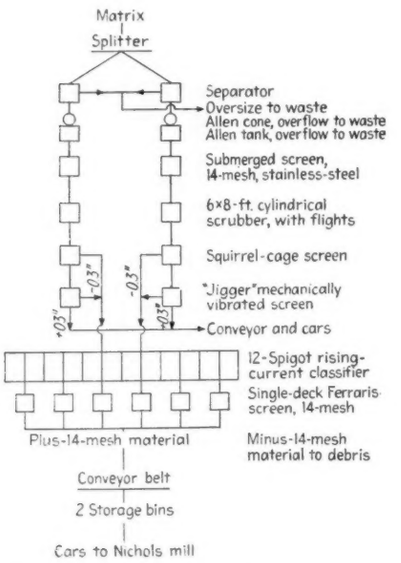


Fig. 7 . . . The flowsheet of No. 43 washing plant of The Phosphate Mining Company, at Nichols

At The Phosphate Mining Company's No. 91 mine, stripping and mining are done with the walking dragline seen at the right. A bench is first cut in the overburden so that the drag cable will not rub on the abrasive dirt

Below, Cars of matrix received at No. 91 washing plant dumping into a sump. In the foreground is a monitor which is used if the dirt hangs up in a car. The soaking given the matrix helps to loosen the clay

A distant view of the No. 91 washing plant

Drying Plant

Although the drying generally marks the end of the technical operation that begins with mining, we inspected the Nichols drying plant first for convenience. Here the rock from the mines is dumped into a number of wet bins before being routed either to the dry bins through the dryers or to the wet storage adjacent to the wet bins. The rock is sent to storage and is reclaimed for drying by means of a drag scraper. There are six different wet storage piles used for six different grades, the total tonnage of which when full is about 75,000.

Drying in the Nichols plant is done to about 1 per cent moisture in five dryers (four Schofield and one Vulcan), with steam atomization, burning oil. The dried product is elevated immediately overhead from the dryers into small larries, which dump the dried rock into a series of bins within a large concrete storage bin having

T. J. Hanley, comptroller of The Phosphate Mining Company at Nichols

E. T. Casler, chemical superintendent

G. R. Barber, operating superintendent

a total capacity of about 30,000 tons of dried rock. This large bin is divided into eight compartments, which permits storing separately eight grades of rock. The tonnage in the storage bins at the time of my visit was low by reason of heavy shipments through Port Tampa, one of which was for loading the Dutch steamer "Weltevreden," its cargo of 10,021 tons being the largest one of phosphate that has ever been sent through this port.

Rock from either mine can be calcined according to customer's specifications in a 6x110-ft. Vulcan kiln. Calcining can be done either to drive off the CO_2 and the organic matter or to remove the organic material only, this in addition to the moisture. Calcining is done at various temperatures required to meet necessities of buyers' specifications. Two separate covered steel tanks of about 4500 tons' total capacity serve for storing the calcined product.

The Phosphate Mining Company operates its own power plant, which furnishes power for its electric furnace, chemical operations, and the mines. This plant is tied in with Tampa Electric Company and also with Florida Public Service Company.

Proceeding next to the No. 43, or Nichols, mine, we found a dragline with 143-ft. boom and an 8-cu.yd. bucket digging and piling the matrix into a sump which had been previously dug in the surface. From this sump the matrix is sluiced by guns to pumps which pump the matrix to the washer. This is a recent development in phosphate mining originated by the company. After the matrix has reached the washer the operation proceeds as customary in the district. In the pit a 200-ft. cut is used. The overburden varies from 20 to 30 ft., and the matrix from 7 to 15 ft., in depth. When this tract was opened about seven years age there was no dragline at this mine, so the overburden was stripped hydraulically. Overburden of the first pit was pumped to adjoining ground across the road. The next adjoining pit was then stripped and this overburden dumped into the mined pit.

The dragline was acquired in 1938 and was initially used for stripping overburden in conjunction with hydraulic mining, until during the last year, when the present newly developed practice referred to was begun.

A short stop was made at the washer that serves this mine at Nichols. Normally it handles 1,000 to 1,500 tons of low-grade (68 per cent B.P.L.) and medium-grade (72 per cent B.P.L.) rock per 8-hour shift.

Stainless Steel Screens

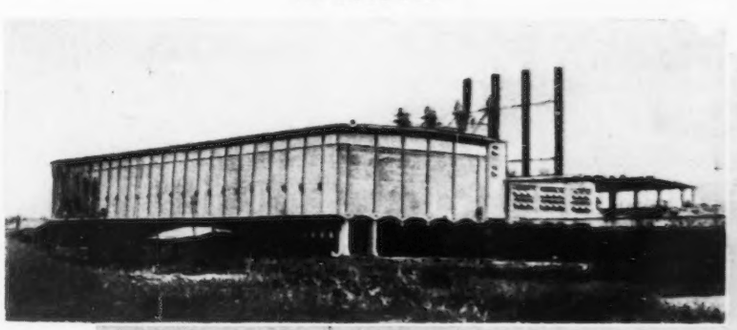
The deposit is not uniform and the grade fluctuates from day to day, but production is classified at the mill so that all shipments are uniform. Pit rock is delivered to a splitter box, which sends half to each section of the washer. The approximate flowsheet is shown in Fig. 7. Allen cones remove the clay and part of the fine sands, the Allen tanks serving as standbys for overflow. The submerged 14-mesh screens following take out more of the fine sand. These were developed by the staff and are of stainless steel and are kept slightly under water on the bottom. The squirrel-cage screens following the cylindrical scrubbers remove some of the minus 0.3-in. material to lighten the load on the "jigger" vibrating screen next in line that cuts out the same size. The plus 0.3-in. size is conveyed to cars for shipment to the dryer. Undersize goes to a 12-spigot rising current classifier, every two spigots of which discharge to one (of six) single-deck Ferraris-type shaking screens. These screens make a separation at 14 mesh, the undersize being sent to waste and the oversize shipped to the mill at Nichols.

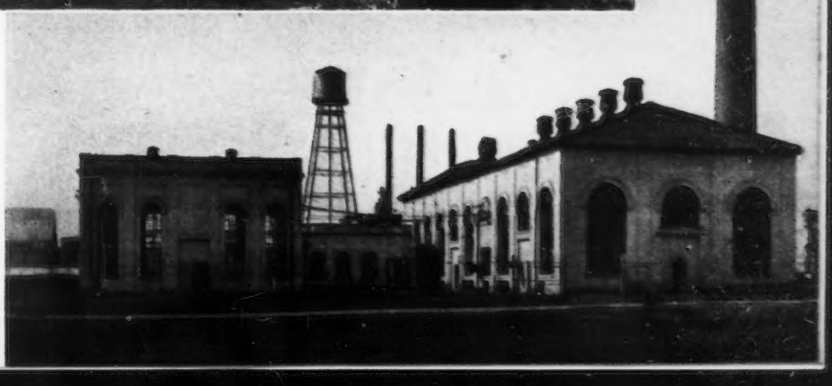
At No. 91, or Phosmico, mine, dry mining developed by The Phosphate Mining Company has completely supplanted the use of hydraulic giants at the pit. This practice has been adopted because here the phosphate in the matrix happens to be soft and of high quality and much would be lost if it were sluiced and pumped. A cut 210 ft. wide is used. The work was being done with a Bucyrus-Monighan dragline of the walking type, equipped with an 8-cu.yd. bucket. The machine was both stripping the overburden and loading the matrix directly into 16- and 20-cu.yd. side-dump cars. Where the overburden was not too deep, the dragline was able to do sufficient stripping between trains to keep the matrix moving.

This tract of ground is said to be full of springs, and it is hard to keep water out of the pits. Under these conditions, the walking-type of excavator and dry mining have proved efficient.

On reaching the washer, the cars of the matrix train are dumped one by one into two concrete sumps, the length of each sump being about that of three cars. When the matrix tends to hang up in a car, the cars are cleaned by sluicing into the sump with a hydraulic gun set up on the surface near by. The soaking of the matrix in the sump and the occasional use of the gun helps to loosen the clay in the matrix, compensating somewhat

The drying plant





The Phosphate Mining Company power plant

for the loss of the advantage normally gained when the matrix is sluiced in the pit and transported hydraulically.

Treatment in the No. 91, or Phosmico, washer is particularly designed for producing rock of high grades up to 77 per cent B.P.L. and also low iron and alumina. Beginning with the sump, it will be noticed that after some preliminary screening of the matrix and treatment in a rake classifier to remove fine sands and slimes, the rake products are again screened and the recovered oversize is allowed to soak overnight in four bins to loosen the clay, by way of final and further cleaning. The company has patents on some of the steps in the No. 91 mine process.

The waste or so-called débris of No. 91 washer is high in B.P.L., as the deposit is a so-called high-grade deposit. It was being stored, to be treated later in a flotation plant which was under construction at the time.

At the No. 91 mine there are two separate wet storages for the several high grades of rock produced at this mine, such as 72 per cent, 75 per cent and 77 per cent grades. Also for grades especially low in iron and alumina. There is also a separate plant for drying the rock, after which shipments are made from this mine direct to the buyer.

The Coronet Phosphate Company's Operations

Coronet Phosphate Company has its local headquarters at Coronet, on the western side of the phosphate district, where also it does its drying and calcining and has its shops and its rarely if ever used standby power plant. Its mine is at Hopewell, approximately 6 miles away. At Coronet attractive quarters have been provided for the staff and working force, the accommodations here including 40 one-family houses for whites (five at Hopewell) and 29 for colored people, as well as a school for the latter. Other facilities include a clubhouse, a baseball field, a tennis court, and a swimming pool. The total force employed is 145 men.

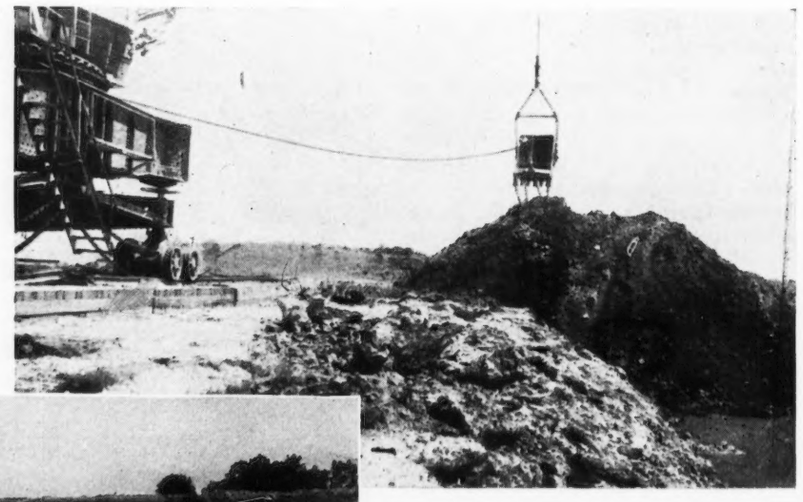
It was at Coronet, in the middle of last May, that I met H. F. Greene, the general manager, by previous arrangement. After giving me an introductory picture of his company's activities, he turned me over to B. G. Dabney, assistant manager, for the day.

At the Hopewell mine, a tract is being worked having an average overburden of 15 to 20 ft. and a 6- to 8-ft. bed of matrix. At the particular point of operations, at the time of my visit, both overburden and matrix were somewhat less than these averages, the former being approximately 9 ft. and the matrix 5 ft. thick.

The mode of operation differs in some respects from that commonly seen in the district. Dragline and giants are used, with a cut 200 ft. wide, the overburden being piled in the adjacent mined-out cut, as commonly done elsewhere, close to the side of a new cut but overlapping it, as one of the photographs shows. The dragline is a Bucyrus-Erie unit with a 150-ft. boom and a 7-cu.yd. steel bucket. Here the overburden is said to be somewhat tough, so that a bucket relatively heavy in proportion to its capacity, in contrast with one built of alloy steel, is considered preferable. The dragline is centered about 50 ft. from the side of the cut on which the overburden is piled.

On starting to strip and mine a cut, on retreat in the usual manner, the overburden is taken from the left side of the cut first, from the end to a point opposite the dragline at about right angles to the cut. The width of this stripped area is as great as will leave a safe place for the dragline to work, which would be about 100 ft. in the 200-ft. wide cut. This leaves the dragline set on the center line of the remaining 100 ft. width of unstripped ground between the old and the new cuts.

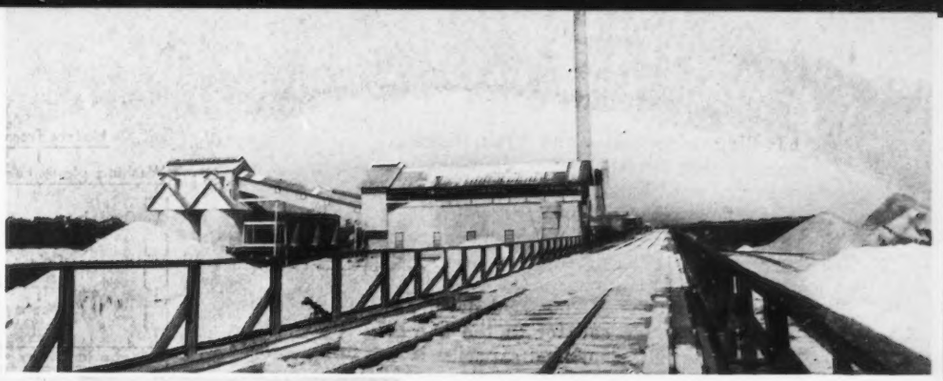
The dragline next digs all of the matrix in the newly stripped area and piles it back in the new cut close to its left edge (the matrix *in situ* along the left edge is first dug up by the dragline to loosen it and dropped back again in the same place, the rest of the matrix being piled on top of it), opposite and parallel to the pile of stripping on the right edge. This done, the dragline next falls back, to be able to use its 150-ft. boom more effectively, and strips the right half of the cut, from the end and up to itself as near as safety will permit, and piles the overburden on top of that already piled along the right-hand edge of the cut. The matrix uncovered in this portion is now dug and heaped on the matrix piled along the left edge. Thus the entire matrix is dug over the full 200-ft. width of the cut and piled in a heap of well-broken-up material ready to be sluiced into the well, or sump, of the pit pump. This pile of broken matrix is now attacked with two monitors, or guns, working under a pressure of about 200 lb. (the hydraulic clear-water pump in the pumping station works at about 220 lb.). Both the clear-water line and the matrix line are kept on the surface along the left edge of the cut parallel with the pile of matrix, the end of each being taken down into the pit, as seen in the photograph, to the pit car pump and the three-way connection, or crowfoot, serving the guns, as the case may be. While this sluicing of the matrix is progressing, a second pit-car pump is rigged up with its well and ditch in



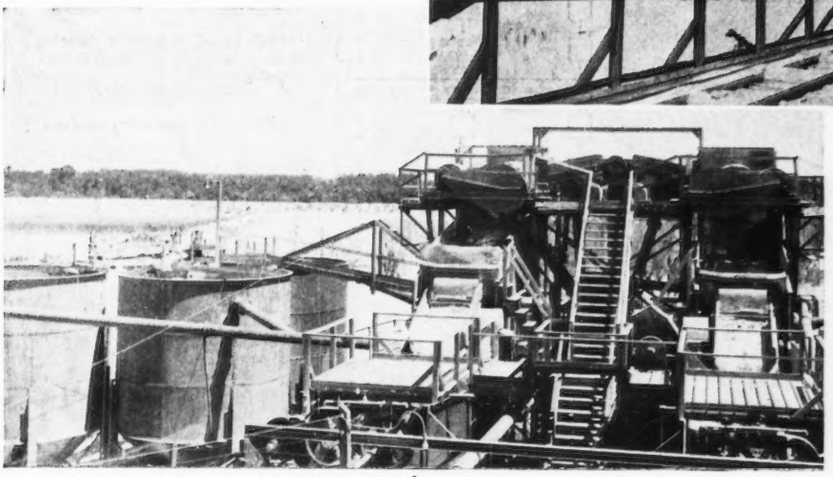
The dragline at Hopewell mine is piling overburden along the right-hand edge of the cut, as explained in the text

At the Coronet Phosphate Company's Hopewell mine, 6 miles from Coronet. The twin installations for sluicing the mined matrix to the washer, as explained in the accompanying text, are shown

Drying and calcining plant of the Coronet Phosphate Company, at Coronet. This view was taken from a wet-storage trestle. The stack is 258 ft. high



Part of the Hopewell washer seen from the platform between the elevators that deliver the washed rock to the bins



B. G. Dabney, assistant manager of Coronet Phosphate Company, left. At right, W. T. Whitney

the pit about 150 ft. in advance of the one in use. Its discharge line is connected to the matrix line on the surface all ready to be placed in service as soon as the guns have advanced to the point where the first pit car will have to be moved ahead. Similarly, two other guns with their hydraulic line have been cut into the clear-water line on the surface at the point opposite the second pit car. Thus when the time comes for moving the first two guns and their pit car ahead, the pit crew simply begins using the advance duplicate installation, so that no time is lost in moving.

As soon as the shift in position is made, the original installation of pit car, guns, and the piping running down to them in the pit from the two lines up on the bank, is moved ahead 150 ft. beyond the one now in service.

This use of a duplicate pit installation obviates all delay in moving and is facilitated by the practice of digging and piling the matrix along the side of the pit as described. The latter practice also makes it easier to sluice the matrix. The method represents an economy in practice dictated by the existing severe competition.

Work on this tract was begun in August, 1938. At present operations are on a basis of 32 hours per week. The pit crew consists of six men, with a so-called "floating" gang of eight for general work, as usual in the district.

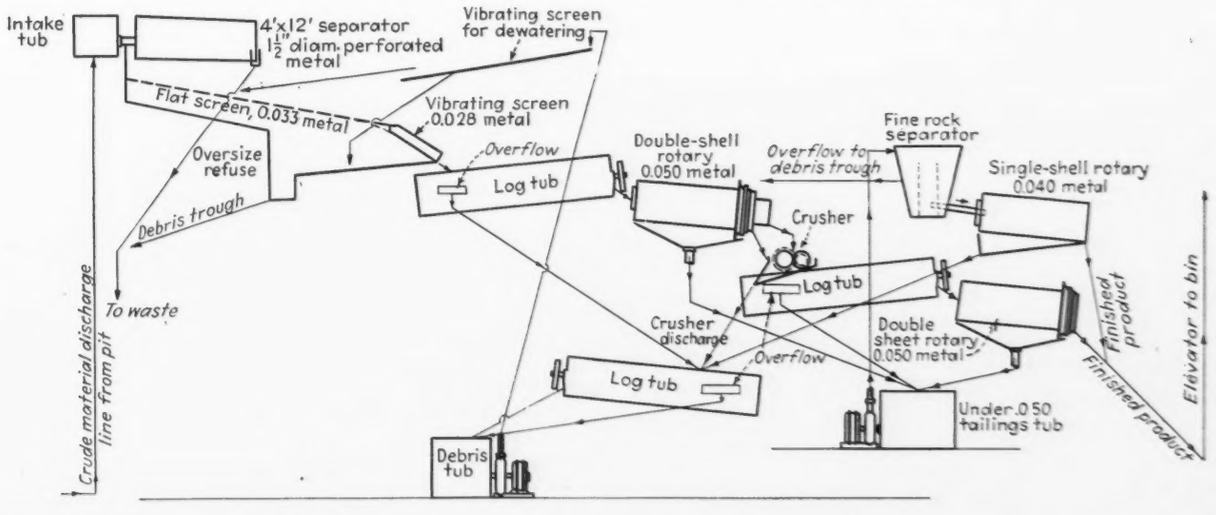
The pump station at Hopewell houses six pumps for pressure on the hydraulic line to the guns and for the washer. Two of these pumps are 3,000 g.p.m. units, working at 200-lb. pressure and driven by a 500-hp. synchronous motor.

The Washing Plant — Treatment given the phosphate pebble at Hopewell washing plant is shown on the accompanying flowsheet, Fig. 8. All overflows and waste are sent to a G. I. W. double log washer, the product being returned to a pair of dewatering screens above the flat screens at the head of the flowsheet. Nothing leaves the mill except that it is small enough to go through a 20-mesh screen.

Bolted steel construction features the Hopewell washer. The present site is the third that it has occupied. Originally it stood at Mary Lee and was subsequently moved to a second site at the same place. Then it was freighted to its present location at Hopewell 15 miles away.

Drying and Calcining—All drying is done at Coronet. Ample facilities for storing wet material are provided. At times as much as 300,000 tons has been stored. Storage is effected by first dumping the railroad cars from a trestle on the ground and then re-

Fig. 8 . . . Flowsheet of Coronet Phosphate Company's washing plant at Hopewell



handling with crane and grab, these being either Brownhoist or Browning.

Four "wet" bins supply the dryers, rock being taken from storage to secure the grade desired for any particular order. The drying is done to 1 per cent moisture on the average in four 42-in. by 30-ft. Schofield dryers, the gases moving counter to the flow of the material. Combined capacity is 50 tons per hour. Here the dryers are run at 13 r.p.m. They can be run up to 20 r.p.m., giving more capacity. These Schofields have spiral flights inside of 45 to 20-deg. and are unlined. Each is moved by a 15-hp. motor and a speed reducer.

The drying and calcining plant is equipped with what used to be the highest stack in Florida (and maybe still is). It was erected in 1920-21. It is 258 ft. in height.

For calcining there are two 8x140-ft. rotary kilns, each making one revolution in 70 seconds and each is driven by a 35-hp. motor. Phosphate rock is calcined at 1,600 to 2,200 deg. F. The calcining (2,200 deg.) burns off all organic matter and carbon or, at a lower temperature, the carbon may be just charred. This calcined phosphate is employed in making a water-white phosphoric acid (H_3PO_4). Each kiln has a capacity of 12 to 16 tons of rock an hour. Each is lined with Alamo brick from Harbison Walker.

Hot rock from the calcining furnace is dumped into an elevator, then by a chute into a cooler which is an unlined shell 6x30 ft. in dimensions, having cold water circulated through pipes running back and forth on the inside next to the shell and parallel with the length. These pipes run between the lifter flights. A fan pulls air through the cooler counter-current and passes it through a dust collector. Calcined (or dried) material goes to dry storage. Concrete bins of 10,000 tons' capacity are provided for storing calcined material. For dried material there are wooden bins of similar capacity.

When calcining has to be done, it is done continuously—three shifts a day and seven days a week. The drying plant at the time was being run on three shifts, five days a week.

Fuel oil used in drying and calcining is atomized with a 3,600-r.p.m. blower, with 4-lb. air, made by United States Hoffman Machinery Corporation, Syracuse, N. Y., and driven by an Allis-Chalmers motor.

The company has its own power plant, not now in use. Power is bought from the Tampa Electric Company, which delivers the current to its own substation at 66,000 volts, then to Coronet at 13,000 volts, which is stepped down by the latter for the most part to 2,300 volts for mining. Considerable 440-volt current is used for drying and in the shops.

After viewing the Coronet Phosphate Company's operations, I was driven to Lakeland by Mr. Greene, to whom I am indebted for a full and interesting day.

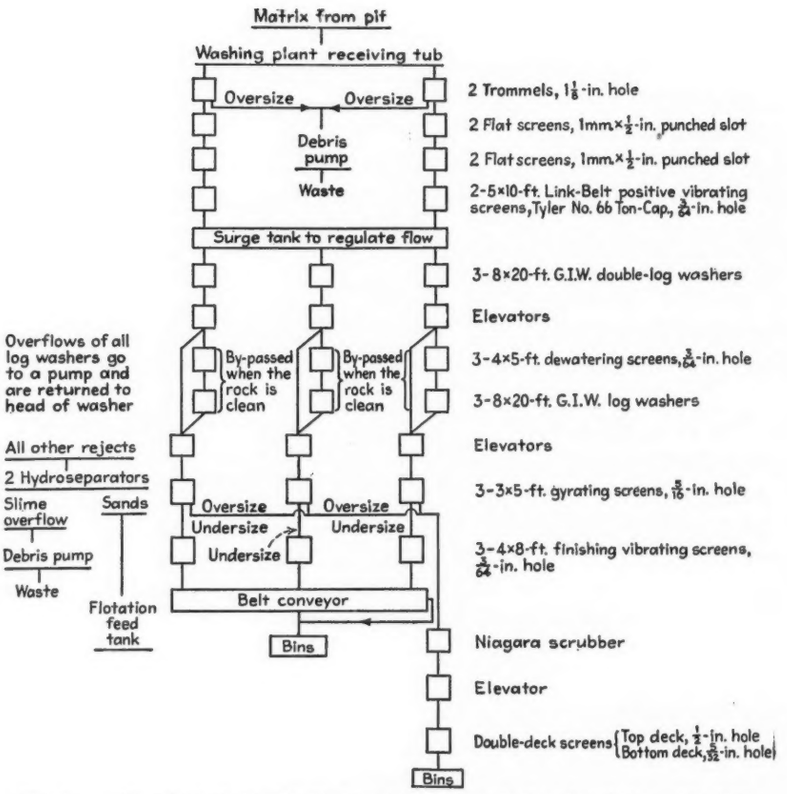


Fig. 9 . . . Flowsheet of the "double" washer that treats the phosphate matrix from Swift No. 4 mine. See Fig. 10

Swift & Company Fertilizer Works, at Agricola

The call that completed my visit with the seven phosphate rock producers in the pebble field was on Swift & Company Fertilizer Works, as the phosphate producing and fertilizer manufacturing subsidiary of Swift & Company, Chicago, is known. Its headquarters are at Agricola (here accented on the third syllable, not on the second as many are accustomed to pronounce it).

At Agricola, in addition to the office, is the drying plant, which we forebore to visit, it being much like others already seen.

The company also has a fertilizer plant at Agricola which manufactures complete fertilizer. Superphosphate is mixed with other substances containing elements essential to plant growth.

Normally, about three hundred men are employed by the company in the pebble district. Work in general was being conducted on two 8-hour shifts per day, five days per week, save at the dryer, which ran intermittently, sometimes 24 hours a day and sometimes not at all, depending on orders.

Swift No. 4 mine was the only one being operated. It is approximately 10 miles from Agricola, and south of Fort Meade. The overburden varies in depth, averaging 20 to 22 ft. At the particular point of work at the time of my visit it was a little deeper. Depth of matrix varies, and it was about 12 ft. when I was there. According to the mine superintendent, D. M. Wright, the material then being mined yielded a medium-grade pebble and high-grade concentrates by both the agglomeration and flotation processes.

Stripping was being done with a Page electric walking dragline having a 160-ft. alloy-steel boom and an 8-cu.yd. Page bucket. A detail of the stripping practice was to cut first an 8-ft. bench in the overburden in front of the dragline, so as to permit the subsequent stripping to be done without having the drag cable rubbing in the dirt, this being quite abrasive.

The dragline averaged about 600 cu.yd. of stripping per hour. Ordinarily the cut made would be about 200 ft. wide, the overburden being piled in the adjacent mined-out cut. At this place, however, the procedure was somewhat irregular, inasmuch as the cut being made was the final one of the section being mined and lay between two mined-out sections. The strip was over 250 ft. wide, at least in places. Despite this, operations were being conducted without any great departure from the individual practices previously recorded.

In mining, the hydraulic line and the matrix line were being carried on the surface along the left edge (with re-

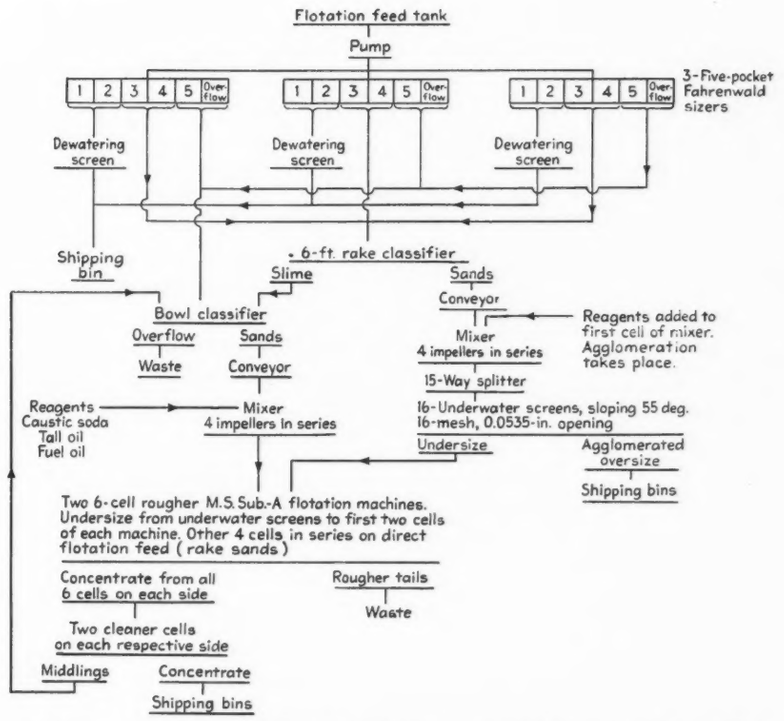


Fig. 10 . . . Flowsheet showing the treatment, by underwater screening and flotation, of the sands produced from the washing plant rejects by the two hydroseparators shown in Fig. 9

spect to the dragline) of the pit. The pit car was in the pit and the matrix and water lines were taken steeply down into the pit, at right angles to the lines on the bank, opposite the car wherever it might be. The well, or sump, was moved every 100 to 120 ft., which meant about every two or three days, according to Mr. Wright, under the prevailing conditions. For both lines 14-in. steel casing with welded flanges was used.

Three guns were provided, two being in operation, with one for moving. The water pressure was 185 lb., the lowest noted in the district. At the clear-water pump in the pump station the pressure was 200 lb. This "pump," however, was really two single-stage centrifugal pumps in series and from the discharge line of the first stage a Y branch took off some water for washing, which reduced the pressure at the guns. The pit car had a 10-in. G.I.W. pump and was about 2,000 ft. from the washer, with two identical pumps as boosters at points between.

The pit crew was somewhat bigger than usual, consisting of about 12 men. This was due to the irregularity of the operations at the time.

Two years ago, approximately, the washing and recovery plant that serves No. 4 mine was placed in commission. It stands about 2,000 ft. from the pit. The washer is of the double variety and is said to have a capacity of 150 tons of pebble per hour.

One of the features of recovery of fine phosphate at the Swift plant was the use of under-water screen separation of agglomerated phosphates from sand. The particular fraction of phosphates recovered by under-water screening consists of particles that are too fine for recovery by the washer and too coarse for flotation. At the time of my visit in May, a 16-mesh screen deck, having an 0.0535 in. opening, was in use on the washer. The undersize material was used as feed for under-water screening and flotation. An approximate flowsheet of the plant is presented in Figs. 9 and 10.

The reagents used are caustic soda, tall oil, which is a byproduct from paper manufacture, and fuel oil.

Ahead of the sixteen underwater screens a 15-way splitter is shown in the flowsheet. Its function is to split 15 ways, thus permitting any one of the 16 screens to be blanked off for repair.

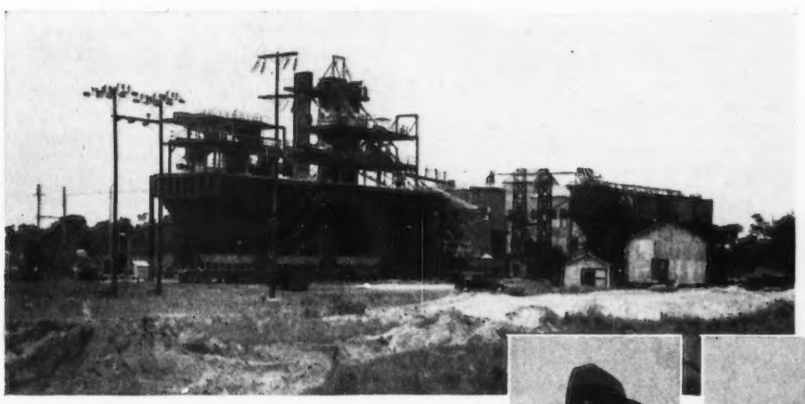
The cleaner flotation cells are heavily loaded and are provided each with a four-blade paddle for removing the froth.

Over-all recovery for the flotation and agglomeration part of the plant is approximately 90 per cent, the concentrates containing about 5 per cent insoluble. The millmen are checked on the percentage of insoluble.

Power for all operations is bought by Swift from Florida Public Service, subsidiary of Associated Gas & Electric Company. The latter brings it to its own substation at 66,000 volts and delivers it at 33,000 to Swift, which steps it down to 2,300 volts. Some 440 volt current is also used.

In the January issue—The Tennessee phosphate field is visited.

(To be concluded)



The washing and recovery plant that serves Swift No. 4 mine is about two years old. It is a "double" or two-unit plant and has a capacity of 150 tons of pebble rock per hour. See Figs. 9 and 10

D. M. Wright, mine superintendent, Swift & Company Fertilizer Works, Agricola

Swift No. 4 phosphate mine, approximately 10 miles from Agricola. The overburden varies in depth from 20 to 22 ft. The dragline, a Page electric walking model, has a 160-ft. alloy-steel boom and an 8-cu.yd. bucket

United States Buys Bolivian Tin Ores

Terms of contract under which Metals Reserve Company is to purchase 90,000 gross tons of fine tin in five years

ON Nov. 4, 1940, the Metals Reserve Company, an agency of the Reconstruction Finance Corporation, entered into a five-year contract with certain Bolivian producers for the annual purchase of tin ore and concentrates containing about 18,000 long tons of fine tin. The effective date of the contract was July 1, 1940. It was signed for the sellers by Carlos V. Aramayo, president and managing director of Compagnie Aramayo de Mines en Bolivie; Mauricio Hochschild, president of The Compañia Minera de Oruro group and of Compañia Minera Unificada del Cerro de Potosi; George A. Easley, agent for Asociacion Nacional de Mineros Medianos; and by Richard M. Vargas, agent for the Banco Minero de Bolivia. For the buyer the contract was signed by Charles B. Henderson, president of Metals Reserve Company, and approved by Jesse H. Jones, Federal Loan Administrator. Performance of the contract was guaranteed by the Government of the Republic of Bolivia.

Text of the contract has been made public and we publish herewith extracts of special interest, relating particularly to treatment charges, premium, penalties, and deductions for smelter losses. Where "ores" are mentioned in the contract, the term is to be construed as including concentrates.

Quantity

Sellers shall sell and deliver to buyers ores containing approximately 18,000 tons of 2,240 pounds each of fine tin per year for a period of five years, commencing July 1, 1940, subject, however, as hereinafter provided, to the quotas established by the International Tin Committee. In the event that the Bolivian production quota under the International Tin Control Scheme is reduced below the amount of the present Bolivian production, the amount of ores to be delivered to the buyer for the year affected by the quota reduction may be reduced to an amount which will bear approximately the same ratio to the reduced Bolivian production quota as 18,000 long tons bears to the present Bolivian production. The amounts of ore to be supplied by any one of the sellers or individual producers shall be determined by the Government of the Republic of Bolivia.

Quality

The ores to be delivered under this Contract shall meet the following requirements:

(a) Not more than 20 per cent of the deliveries may contain under 35 per cent tin content but no concentrates shall have less than 18 per cent; at least one-quarter of this 20 per cent, however, must be above 25 per cent tin content;

(b) Not less than 30 per cent of the deliveries must be in excess of 55 per cent tin content;

(c) Not less than 45 per cent of the deliveries must be in excess of 45 per cent tin content; and

(d) Not less than 80 per cent of the deliveries must be in excess of 35 per cent tin content.

Adjustment shall be made during each three-month period, beginning three months after the date of the first delivery of ores in the United States, to compensate for deliveries of ores having a tin content less than that permitted under (d) above made during the preceding three-month period.

No stannite or thealite concentrates or ores shall be accepted under this contract.

Price

For the first 18,000 long tons of tin, if made available to Buyer before July 1, 1941, the price of the tin content of the ores shall be 48½¢. per pound of tin less treatment charges and penalties for impurities and less stipulated units for smelting losses.

(a) Thereafter, if the buying price of tin of Metals Reserve Company (established in agreement with the International Tin Committee covering maximum price basis) is 50¢. or more per pound, or if Sellers elect to accept the Metals Reserve Company buying price if it is less than 50¢. per pound, the price of the tin content of the ores shall be 1½¢. per pound less than the said buying price less treatment charges and penalties for impurities and less stipulated units for smelting losses; or

(b) Thereafter, in the absence of such a Metals Reserve Company buying price, the price of the tin content of the ores shall be 1½¢. less than the average price per pound of the New York Straits spot and three months forward delivery month as published in the American Metal Market, calculated for seven business days following the fifteenth day after arrival of the ores at a United States port, less treatment charges and penalties for impurities and less stipulated units for smelting losses.

Duty, if any, on the ores purchased under this contract shall be for Buyer's account.

Shipment

The ores shall be shipped by Sellers for Buyer to f.o.b. cars or docks according to Buyer's instructions, United States port or ports designated by Buyer, during the period of this contract in approximately equal monthly quantities; such shipments shall commence as soon as Buyer indicates to Sellers' Agents in writing that storage facilities at the smelter site or sites are available. Sellers shall cause to be effected and in force in favor of Buyer such insurance, including war risk insurance, for such periods and in such amounts as may be required by Buyer and in such companies as may be satisfactory to Buyer on ores on which advances have been made in Chilean ports. All costs of such insurance, including war risk insurance, together with freight and storage charges and all other costs incurred in connection with the shipment of the ores to the United States, shall be for the account of Sellers. All parties shall cooperate to secure normal freight rates to the United States ports selected by Buyer. Shipment shall be made in vessels registered under the flag of any of the American Republics if sufficient tonnage is available at competitive rates. Shipping arrangements shall be decided upon by agreement between the Government of the Republic of Bolivia and the Metals Reserve Company.

Treatment Charges (Premiums and Discounts) Penalties for Impurities and Smelting Loss Deduction

A. Tin Ores Above 55 Per Cent

1. Tin contents less one unit to be paid for as stipulated below.

2. Treatment Charge and Penalties:

a. Treatment Charge:

For ores containing a minimum of 55 per cent tin and a maximum of one per cent antimony, arsenic, bismuth, copper, lead and zinc combined. (Antimony and lead combined shall not exceed 0.3 per cent.)

(i) $30.40 per ton of 2,240 pounds basis 60 per cent with

(ii) $1.20 per unit decrease up to 65 per cent then

(iii) $0.60 per unit above 65 per cent or

(iv) $1.20 per unit increase down to 55 per cent, fractions pro rata.

b. Penalties:

Sulphur 3 per cent free—any excess to be penalized at $0.23 for each 0.1 per cent pro rata.

3. Any parcel of ore above 55 per cent tin, but not conforming strictly to the foregoing (under No. 2) specifications, will be subject to the following treatment charges and impurity penalties:

a. Treatment Charge:

$31.60 per ton of 2,240 pounds basis 60 per cent with variations as above in 2a-(ii) (iii) and (iv).

b. Penalties:

Arsenic, copper, bismuth and zinc, combined up to 0.5 per cent free, excess penalized at $0.45 for each 0.1 per cent pro rata.

Antimony and lead combined 0.5 per cent free, excess penalized at $0.45 for each 0.1 per cent pro rata up to a maximum allowed combined contents of antimony and lead of 2.25 per cent of which antimony shall not exceed 0.5 per cent and lead 1.75 per cent.

Sulphur 3 per cent free, excess to be penalized at $0.23 for each 0.1 per cent pro rata.

4. Any parcel of ore above 55 per cent tin but having in excess of 1.75 per cent lead and in excess of 0.5 per cent antimony, will be subject to

a. Treatment Charge:

$32.25 per ton of 2,240 pounds basis 60 per cent tin with variations as above in 2a (ii), (iii) and (iv).

b. Penalties.

Arsenic, copper, bismuth, and zinc combined as above (3-b).

Lead: 1 per cent free, each 0.1 per cent in excess of 1 per cent up to 2 per cent to be penalized at $0.45. Each 0.1 per cent in excess of 2 per cent up to 4 per cent to be penalized at $0.70. Each 0.1 per cent in excess of 4 per cent to be penalized $0.80 pro rata.

Antimony: 0.5 per cent free, each 0.1 per cent in excess of 0.5 per cent up to 0.75 per cent to be penalized $0.45. Each 0.1 per cent in excess of 0.75 per cent up to 1 per cent to be penalized $0.70 pro rata. If antimony exceeds 1 per cent special terms shall be arranged for the excess.

Sulphur: 3 per cent free, excess to be penalized at $0.23 for each 0.1 per cent pro rata.

B. Tin Ores Between 35 Per Cent and 55 Per Cent

1. Tin content less 1¼ unit will be paid for based upon a tin content of 55 per cent and to be increased by 0.05 of a unit for each unit of tin content below 55 per cent, fractions pro rata.

Example:	Units
55%—1¼ unit	= 1¼
52%—1¼ unit + 3 × 0.05	= 1.40
40%—1¼ + 15 × 0.05	= 2.00
38.72%—1¼ unit + 16.28 × 0.05	= 2.064

2. Treatment Charge and Penalties:

a. Treatment Charge:

(i) $35.00 per ton of 2,240 pounds basis 55 per cent tin.

(ii) $0.23 per unit increase below 55 per cent tin.

(iii) Price Adjustment: The above treatment charge also to be based upon a tin price of $936 per ton of 2,240 pounds and to be increased $0.0125 for each dollar above this price.

b. Penalties:

Antimony, lead, bismuth, copper and arsenic combined up to 3 per cent free, excess penalized at $0.35 for each 0.1 per cent pro rata. This schedule valid for all ores containing up to 5 per cent antimony, lead, bismuth, copper and arsenic combined: however, if these combined impurities exceed 5 per cent, the following additional individual penalties are to be applied:

Antimony: In excess of 1.2 per cent @ $0.45 per 0.1 per cent.

Arsenic: In excess of 0.2 per cent @ $0.45 per 0.1 per cent.

Zinc: In excess of 3 per cent @ $0.12 per 0.1 per cent, but with a maximum of $7.05 per ton of ore. All fractions pro rata.

Sulphur: 3 per cent free.

	Per Ton of ore
Over 3% up to 5%	$2.35
Over 3% up to 10%	4.70
Over 10% up 15%	7.05
Over 15%	9.40

C. Tin Ores Between 18 Per Cent and 35 Per Cent

1. Tin content less 1.5 unit to be paid for.

2. Treatment Charge and Penalties:

a. Treatment Charge:

(i) $42.25 per ton 2.240 pounds basis 25 per cent tin.

(ii) $0.60 per unit increase above 25 per cent or

(iii) $0.30 per unit decrease below 25 per cent.

(iv) Price Adjustments: The above treatment charge also to be based upon a tin price of $936 per ton of 2.240 pounds and to be increased $0.0125 for each dollar above this price.

b. Penalties:

Antimony: Not to exceed 2.50 per cent.

Copper: 1.5 per cent free, excess penalized @ $0.23 per 0.1 per cent.

Zinc: 3 per cent free, excess penalized $0.12 per 0.1 per cent. (Maximum $7.05 per ton of ore.)

Arsenic: 0.2 per cent free, excess penalized @ $0.45 per 0.1 per cent.

Bismuth. 0.2 per cent free, excess penalized @ $0.45 per 0.1 per cent.

Sulphur: 3 per cent free, excess penalized @ $0.45 per unit, up to 12 per cent and $0.23 per unit above 12 per cent. (All fractions pro rata.)

Advances:

Promptly after the execution of this Contract, payment of 80 per cent of the purchase price shall be made on ores placed in the custody of Buyer's representative at Chilean ports after satisfactory sampling and analysis; provided, however, that if such ores are not shipped for smelting within four months after placing the ores in the custody of Buyer's representative, an additional payment of 10 per cent of the purchase price will be made. Such advances shall be discontinued when the ores can be received, sampled, and analyzed at the smelter site.

Payments and Adjustments

Payment in full after adjustments to Sellers' agent will be made after arrival of the ores at the smelter site in the United States and after weighing, sampling and analysis of the ores at the smelter: such date of payment to be not later than 30 days after arrival of steamer and receipt by buyer of complete original set of documents.

(a) The weighing, sampling and distribution of samples shall take place at the smelting works at Buyer's expense in the presence of Sellers' representatives, the Sellers paying the cost of their own representatives.

(b) Moisture shall be determined at time of weighing.

(c) Three samples shall be made, one of which, to be known as the umpire sample, shall be sealed and retained by Buyer. The remaining two samples shall be analyzed respectively by an analyst to be designated by Buyer and an analyst to be designated by Sellers and the results thereof to be exchanged simultaneously by post. If the difference (if any) in the respective results as to tin content does not exceed 0.5 of one unit and the difference (if any) in the results as to any impurity does not exceed 0.2 of one unit, the average of such two analyses shall be the basis of settlement. However, in the event that the difference as to tin content exceeds 0.5 of one unit, or the difference as to any impurity exceeds 0.2 of one unit, the sealed umpire sample shall be analyzed by one of the following named analysts satisfactory to Buyer and Sellers: Ledoux & Co., Inc., Lucius Pitkin, Inc., John H. Banks Laboratory, Inc., Walker & White, Inc., all of New York.

Should the results of the umpire analysis fall within or coincide with the respective analyses of Buyer's and Seller's analysts, the results of the umpire analysis shall govern. If the umpire shall report a content above the higher analysis or below the lower analysis, then the analysis nearest the umpire analysis shall be the basis of settlement. Cost of the umpire analysis shall be borne by the party whose analyst reported a content furthest from the content determined by the umpire analysis.

Special Conditions

The contract closes with the enumeration of some special conditions relating to future price adjustments and other matters. Of special interest is an item that discloses the impracticability "for the Buyer to require payment hereunder to be used for the purchase of raw or manufactured agricultural commodities to be exported from the United States."

Summary of the

MARKETS

CONSUMPTION of major non-ferrous metals in this country rose to record levels during November. Opposition in Washington to higher prices more than offset a shrinkage in reserves in determining quotations. To establish more orderly markets, defense orders were placed on a basis that no longer obliges fabricators to cover immediately against all long-term requirements at a flat price. Moreover, the threat of imposing priorities on items in which an apparent scarcity exists sobered both buyers and sellers. The fear of not obtaining sufficient supplies of non-ferrous metals moderated appreciably during the last month. The *E. & M. J.* price index for November was 83.14, against 82.49 in October.

Consumption of copper in the United States against domestic and export needs has averaged above 100,000 tons a month during the last two months. Fabricated products exported probably contained from 25,000 to 30,000 tons of copper a month in October and November. Foreign copper will be used hereafter to a greater extent on export business. Discussions in Washington brought out that 1,200,000 tons of copper will be consumed in the United States during 1941, whereas domestic production may not exceed 1,080,000 tons. The Government intends to stockpile foreign metal for use against defense business if needed. Hemisphere defense considerations will enter into the situation, the trade believes. Domestic sales for November totaled 85,004 tons. Producers maintained the quotation at 12c., Valley, throughout the month. Custom smelters again sold near-by copper at a premium. Foreign copper sold down to 10c., f.a.s. New York.

Lead advanced to 5.80c. New York, Nov. 8, but as some business was booked before the higher price was announced, our average for that day was 5.75c. Later the price weakened.

Zinc producers did what they could to satisfy consumers. In the outside market metal sold at a premium. Zinc supply is expected to remain tight over the first quarter of 1941.

The Metals Reserve Company, Washington, purchased Bolivian tin ore and domestic quicksilver.

UNITED STATES MARKET

1940 Nov.	Electrolytic Copper: Domestic (a) Refinery	Electrolytic Copper: Export (b) Refinery	Straits Tin: New York	Lead: New York	Lead: St. Louis	Zinc: St. Louis
1	11.775	10.350	51.125	5.50	5.35	7.25
2	11.775	10.325	51.000	5.50	5.35	7.25
4	11.850	10.450	51.000	5.50	5.35	7.25
5	Holiday	10.200	Holiday	Holiday	Holiday	Holiday
6	11.775	10.225	50.875	5.65	5.50	7.25
7	11.850	10.000	50.875	5.65	5.50	7.25
8	11.800	10.300	51.000	5.75	5.65	7.25
9	11.785	10.300	51.000	5.80	5.65	7.25
11	Holiday	9.950	Holiday	Holiday	Holiday	Holiday
12	11.800	10.050	50.750	5.80	5.65	7.25
13	11.800	9.950	50.750	5.80	5.65	7.25
14	11.775	10.200	50.625	5.80	5.65	7.25
15	11.900	10.200	50.500	5.80	5.65	7.25
16	11.775	10.075	50.500	5.80	5.65	7.25
18	11.800	9.950	50.375	5.80	5.65	7.25
19	11.850	9.950	50.300	5.80	5.65	7.25
20	11.775	9.950	50.250	5.80	5.65	7.25
21	Holiday	10.000	Holiday	Holiday	Holiday	Holiday
22	11.800	9.950	50.375	5.80	5.65	7.25
23	11.775	9.950	50.375	5.80	5.65	7.25
25	11.775	9.975	50.250	5.80	5.65	7.25
26	11.775	9.950	50.300	5.80	5.65	7.25
27	11.825	9.950	50.300	5.80	5.65	7.25
28	11.785	10.050	50.250	5.65	5.50	7.25
29	11.800	9.950	50.250	5.65	5.50	7.25
30	11.775	9.975	50.250	5.65	5.50	7.25
AVERAGES FOR MONTH						
Nov.	11.800	10.084	50.577	5.726	5.578	7.250
AVERAGES FOR WEEK						
Nov.						
6	11.795	10.350	51.050	5.530	5.380	7.250
13	11.807	10.092	50.875	5.760	5.620	7.250
20	11.813	10.054	50.425	5.800	5.650	7.250
27	11.790	9.963	50.320	5.800	5.650	7.250
CALENDAR WEEK AVERAGES						
Nov.						
2	11.813	10.500	51.292	5.500	5.350	7.250
9	11.812	10.246	50.950	5.670	5.530	7.250
16	11.810	10.071	50.625	5.800	5.650	7.250
23	11.800	9.958	50.335	5.800	5.650	7.250
30	11.789	9.975	50.267	5.725	5.575	7.250

SILVER, GOLD AND STERLING EXCHANGE

1940 Nov.	Sterling Exchange: "Checks"	Sterling Exchange: "90-day demand"	Silver (c): New York	Silver (c): London	Gold: London	Gold (d): United States
1	402.0000	(f)	34.750	23.5000	168s	$35.00
2	401.0000	(f)	(e)	(e)	(e)	35.00
4	401.0000	(f)	34.750	23.4375	168s	35.00
5	Holiday	Holiday	Holiday	23.4375	168s	Holiday
6	401.0000	(f)	34.750	23.3750	168s	35.00
7	401.0000	(f)	34.750	23.4375	168s	35.00
8	401.0000	(f)	34.750	23.3125	168s	35.00
9	402.0000	(f)	(e)	(e)	(e)	35.00
11	Holiday	Holiday	Holiday	23.3125	168s	Holiday
12	401.0000	(f)	34.750	23.3750	168s	35.00
13	402.0000	(f)	34.750	23.3125	168s	35.00
14	402.0000	(f)	34.750	23.3125	168s	35.00
15	402.0000	(f)	34.750	23.2500	168s	35.00
16	402.0000	(f)	(e)	(e)	(e)	35.00
18	402.0000	(f)	34.750	23.1875	168s	35.00
19	402.0000	(f)	34.750	23.1875	168s	35.00
20	402.0000	(f)	34.750	23.2500	168s	35.00
21	Holiday	Holiday	Holiday	23.1875	168s	Holiday
22	402.0000	(f)	34.750	23.1250	168s	35.00
23	403.0000	(f)	(e)	(e)	(e)	35.00
25	402.0000	(f)	34.750	23.0625	168s	35.00
26	402.0000	(f)	34.750	23.0625	168s	35.00
27	402.0000	(f)	34.750	23.0000	168s	35.00
28	402.0000	(f)	34.750	23.0000	168s	35.00
29	402.0000	(f)	34.750	22.8750	168s	35.00
30	402.0000	(f)	(e)	(e)	(e)	35.00
AVERAGES FOR MONTH						
Nov.	401.783	.....	34.750	23.238	....	35.00
AVERAGES FOR WEEK						
Nov.						
6	401.200	.....	34.750	.....	....	.....
13	401.400	.....	34.750	.....	....	.....
20	402.000	.....	34.750	.....	....	.....
27	402.200	.....	34.750	.....	....	.....

Calendar week averages, New York Silver: 2nd, 34.750; 9th, 34.750; 16th, 34.750; 23rd, 34.750; 30th, 34.750.

(e) Not quoted (Saturday). (f) No quotations.

THE above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis add 0.225c. per pound, the average differential for freight and delivery charges.

(b) Export prices are net at refineries on the Atlantic seaboard and include sales of domestic copper in the foreign market. Owing to the European War and the disruption of normal trade relations, our export copper quotations, since September, 1939, have been based largely on f.a.s. transactions, ex United States ports. To arrive at the f.o.b. refinery quotations deduct .05 from the f.a.s. basis for lighterage.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingot bars; cathodes are sold at a discount of 0.125c.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade Zinc delivered in the East and Middle West in nearly all instances command a premium of 1c per pound over the current market for Prime Western but not less than 1c over the *Engineering and Mining Journal's* average quotation for Prime Western for the previous month.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

(c) Silver other than newly-mined domestic, by Handy & Harman. Under Treasury order of July 6, 1939, the price on domestic newly-mined silver mined subsequent to July 1, 1939, was fixed at 71.11c per troy ounce. Handy & Harman's quotation on newly-mined domestic silver, 999 fine was 70⅝c throughout November.

(d) U. S. Treasury's gold price. Actual payment by the United States Treasury for gold in domestic and imported ore or concentrate is at 99.75 per cent of the price quoted by the Treasury, which at present is equal to $34.9125.

PRICES OF METALS • MISCELLANEOUS QUOTATIONS

LONDON MARKET

1940 November	Copper Standard Spot	Copper Standard 3 months	Copper Electro Bid	Tin Standard Spot	Tin Standard 3 months	Lead Spot Buyers	Lead Spot Sellers	Lead 3 months Buyers	Lead 3 months Sellers	Zinc Spot Buyers	Zinc Spot Sellers	Zinc 3 months Buyers	Zinc 3 months Sellers
1	Not quoted			258.0000	259.7500	Not quoted							
4	"	"		258.0000	260.0000	"	"						
5	"	"		257.5000	259.7500	"	"						
6	"	"		258.0000	260.0000	"	"						
7	"	"		258.2500	260.2500	"	"						
8	"	"		260.0000	261.7500	"	"						
11	"	"		258.2500	260.2500	"	"						
12	"	"		258.5000	260.2500	"	"						
13	"	"		259.0000	260.5000	"	"						
14	"	"		259.0000	260.7500	"	"						
15	"	"		259.0000	260.5000	"	"						
18	"	"		257.7500	259.7500	"	"						
19	"	"		257.5000	259.5000	"	"						
20	"	"		257.7500	259.7500	"	"						
21	"	"		257.7500	259.7500	"	"						
22	"	"		258.2500	260.0000	"	"						
25	"	"		258.2500	260.2500	"	"						
26	"	"		258.0000	259.7500	"	"						
27	"	"		257.7500	259.7500	"	"						
28	"	"		258.0000	260.0000	"	"						
29	"	"		258.0000	260.5000	"	"						
Average for month...				258.214									

Prices for tin are the official prices of the London Metal Exchange, in long tons (2240 lb.). Trading in other metals remained suspended.

CURRENT PRICES — MISCELLANEOUS METALS, ORES, AND NON-METALLIC MINERALS

Quotations cover wholesale lots, prompt shipment, f.o.b. New York, unless otherwise stated

(Dec. 2, 1940)

MISCELLANEOUS METALS

Aluminum, ingot, 99 plus per cent, lb	17c.
Antimony, domestic, spot, lb	14.00c.
Bismuth, ton lots, lb	$1.25
Cadmium, commercial sticks, lb	80c.
Calcium, lb., ton lots 97 @ 98 per cent	Nominal
Chromium, 97 per cent grade, lb	89c.
Cobalt, 97 to 99 per cent, per lb	$1.50
Nickel, electrolytic cathodes, lb	35c.
Magnesium, 99.8 per cent, carloads, lb	27c.
Palladium, troy oz	$24.00
Platinum, (Official quotation) troy oz	$36.00
Quicksilver, flask of 76 lb., 100 flasks or more	$168.00
Radium, mg. radium content	$25.00@$30.00
Selenium, 99.5 per cent, lb	$1.75
Silicon, minimum 97 per cent, spot, lb	16.50c.
Tellurium, lb	$1.75
Thallium, 100 lb. or more, lb	$10.00
Titanium, 96 to 98 per cent, lb	$5.00

METALLIC ORES

Beryllium Ore, f.o.b. mines, ton	$30.00@$35.00
Chrome Ore, 48 @ 50% Cr_2O_3 c.i.f. Atl. ports, long ton	(b)$32.00@$34.00
Iron Ore, Lake Superior, Lower Lake ports, long ton:	
Old Range bessemer	$4.75
Mesabi bessemer	$4.60
Old Range non-bessemer	$4.60
Mesabi, non-bessemer	$4.45
Lead (Galena) 80 per cent, Joplin, Mo., ton	$66.70
Manganese Ore, (foreign) c.i.f. U.S. ports, long ton unit of Mn:	
52 @ 55 per cent	(b) 55c.
50 @ 52 per cent	(b) 55c.
46 @ 48 per cent	(b) 48@50c.
Molybdenum Ore, 90%, per lb. of MoS_2, f.o.b. mines	45c.
Tungsten Ore, per unit of WO_3:	
Chinese, 65 per cent, duty paid	$24.50
Domestic, 65 per cent and upward	(a) $24.00
Vanadium Ore, per lb. of contained V_2O_5	27½c.
Zinc Ore, Prime, 60 per cent concentrate, Joplin, Mo.; per ton	$48.00

(a) Prices at mines, small lots, usually several dollars less. (b) Nominal.

METALLIC COMPOUNDS

Arsenious Oxide (arsenic) lb	3½c.
Cobalt Oxide, 70 @ 71 per cent, lb	$1.84
Copper Sulphate, 100 lb	$4.75
Sodium Nitrate, ex vessel, in 200-lb. bags, per 100 lb	$1.42
Sodium Sulphate, bulk ton	$17.00@$18.00

ALLOYS

Beryllium Copper, master alloy, 2.5 to 3 per cent Be, per lb. of contained Be	$15.00
Ferrochrome, 65 @ 70 per cent chromium, 4 @ 6 per cent carbon, lb	11c.
Ferromanganese, 78 @ 82 per cent, gross ton	$120.00
Ferromolybdenum, 55 @ 65 per cent Mo. lb. of Mo. contained	95c.
Ferrosilicon, 50 per cent, gross ton	$74.50
Ferrotungsten, 75 @ 80 per cent, lb. of W contained	$1.90@$2.00

NON-METALLIC MINERALS

Asbestos, f.o.b. mines (U.S. funds), ton:	
Canadian (Quebec)	
Crude No. 1	$700@$750
Crude No. 2	$150@$350
Spinning fibers	$110@$200
Paper stock	$40@$45
Shorts	$13@$17.50
Vermont	
Shingle stock	$57
Paper stock	$40
Cement stock	$25
Barytes, long ton:	
Georgia, crude	$7.00
Missouri, 93 per cent $BaSO_4$, less than 1 per cent iron	$6.00@$6.00
Bauxite, long ton:	
Domestic, chemical, 55 @ 58 per cent	$7.00@$8.00
Domestic, abrasive, 80 @ 84 per cent	$14.00
Dalmatian, 50 @ 55 per cent	Nominal
French, 56 @ 59 per cent	Nominal
China Clay, f.o.b. mines, ton:	
South Carolina and Georgia, No. 1, bulk	$6.75@$8.00
Delaware, No. 1	$14.50
Feldspar, bulk, ton:	
Potash feldspar, 200 mesh	$17.00
Glass-spar, white, 20 mesh	$11.75
Fluorspar, f.o.b. mines, bulk, Kentucky and Illinois 85–5 per cent, all rail movement, ton	$19.00
Fuller's earth, f.o.b. Georgia or Florida, ton	$7.00@$14.00
Magnesite, per ton:	
Dead-burned, f.o.b. California	$25.00
Dead-burned, f.o.b. Washington	$22.00
Mica, per lb., North Carolina, No. 1 and 2 quality:	
1½ x 2 in.	45@60c.
2 x 2 in.	60@80c.
3 x 3 in.	$1.25@$1.50
3 x 4 in.	$1.50@$1.75
3 x 5 in.	$1.75@$2.25
White, ground, 70 mesh, ton	$60.00@$80.00
Ocher, Georgia, ton	$19.00@$22.00
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports	(a) 12c.
Silica, in bags, 325 mesh, ton	$20.00@$40.00
Sulphur, Texas, mines, long ton	$16.00
Talc, f.o.b. works, ton:	
New York, double air-floated, 325 mesh	$12.00@$15.00
New Jersey, mineral pulp	$8.50@$10.50
Vermont, extra white, 200 mesh	$9.50@$10.00
Tripoli, Missouri, ton:	
40 mesh, cream colored	$14.50
200 mesh, cream colored	$26.00

(a) Nominal

IRON AND STEEL

Pig Iron, Valley furnaces, gross ton:	
Bessemer	$23.50
Basic	$22.50
No. 2 Foundry	$23.00
Steel, base prices, Pittsburgh:	
Billets, gross ton	$34.00
Structural shapes, 100 lb	$2.10
Bars, 100 lb	$2.15

Monthly and Yearly

AVERAGE PRICES

SILVER AND STERLING EXCHANGE

	New York		London Spot		Sterling Exchange	
	1939	1940	1939	1940	1939	1940
January	42.750	34.750	20.305	21.892	466.775	395.442
February	42.750	34.750	20.370	20.935	468.472	395.652
March	42.750	34.750	20.280	20.763	468.370	375.212
April	42.750	34.750	20.031	20.713	467.778	351.817
May	42.750	34.949	20.123	21.878	467.988	326.452
June	41.955	34.825	19.505	22.688	468.137	359.560
July	34.944	34.750	16.952	22.095	468.031	379.750
August	35.951	34.750	17.719	23.261	460.383	396.889
September	36.956	34.750	22.178	23.446	398.820	401.646
October	35.726	34.750	22.736	23.451	400.350	401.692
November	34.750	34.750	23.378	23.238	391.457	401.783
December	34.956	.....	23.263	.....	391.830	.....
Year	39.082	.....	20.570	.....	443.199	.....

New York quotations for silver other than newly-mined domestic, cents per ounce troy, 999 fine, London pence per ounce sterling silver 925 fine. Sterling exchange (pound sterling) in cents.

COPPER

	F.O.B. Refinery, Electrolytic				London Spot			
	Domestic		Export		Standard		Electrolytic (a)	
	1939	1940	1939	1940	1939	1940	1939	1940
January	11.025	11.954	9.912	11.999	43.125	(b)	48.440	(b)
February	11.025	11.148	9.735	11.471	42.188	(b)	47.375	(b)
March	11.025	11.160	9.888	11.407	42.938	(b)	48.120	(b)
April	10.265	11.087	9.820	11.258	42.031	(b)	47.833	(b)
May	9.833	11.079	9.738	11.191	41.656	(b)	47.528	(b)
June	9.775	11.128	9.738	11.216	41.986	(b)	47.528	(b)
July	9.976	10.564	9.944	10.189	42.899	(b)	48.863	(b)
August	10.261	10.708	10.211	9.851	44.685	(b)	50.409	(b)
September	11.635	11.296	11.685	9.849	(b)	(b)	(b)	(b)
October	12.215	11.826	12.491	10.436	(b)	(b)	(b)	(b)
November	12.275	11.800	12.929	10.084	(b)	(b)	(b)	(b)
December	12.275	.....	12.631	.....	(b)	.....	(b)	.....
Year	10.965	.....	10.727	....	(c)42.689	.....	(c)48.262	.....

New York quotations, cents per pound. London, pounds sterling per long ton. (a) Bid quotations. (b) No quotations. (c) Average for eight months.

LEAD

	New York		St. Louis		London			
					1939	1939	1940	1940
	1939	1940	1939	1940	Spot	3 mos.	Spot	3 mos.
January	4.826	5.471	4.676	5.321	14.534	14.744	(a)	(a)
February	4.805	5.076	4.655	4.926	14.283	14.417	(a)	(a)
March	4.824	5.192	4.674	5.042	14.660	14.860	(a)	(a)
April	4.782	5.071	4.632	4.921	14.337	14.533	(a)	(a)
May	4.750	5.015	4.600	4.865	14.483	14.679	(a)	(a)
June	4.800	5.000	4.650	4.850	14.564	14.651	(a)	(a)
July	4.854	5.000	4.704	4.850	14.753	14.856	(a)	(a)
August	5.043	4.854	4.893	4.704	16.040	15.885	(a)	(a)
September	5.449	4.929	5.299	4.779	(a)	(a)	(a)	(a)
October	5.500	5.308	5.350	5.158	(a)	(a)	(a)	(a)
November	5.500	5.726	5.350	5.578	(a)	(a)	(a)	(a)
December	5.500	.....	5.350	.....	(a)	(a)	.....	.....
Year	5.053	.....	4.903	....	(b)14.707	(b)14.828	.....	.....

New York and St. Louis quotations, cents per pound. London pounds sterling per long ton. (a) No quotations. (b) Average for eight months.

TIN

	Straits New York		Standard, Spot London	
	1939	1940	1939	1940
January	46.404	46.707	215.435	240.716
February	45.640	45.851	213.906	242.833
March	46.213	47.079	215.375	251.711
April	47.160	46.815	218.389	252.080
May	49.031	51.570	225.591	264.098
June	48.853	54.618	227.511	273.438
July	48.548	51.591	229.833	265.592
August	48.793	51.176	229.869	262.455
September	64.588	50.348	229.292	251.024
October	55.580	51.490	229.943	257.946
November	52.322	50.577	230.000	258.214
December	50.740	.....	248.974	.....
Year	50.323	.....	226.177	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

ZINC

	St. Louis		London			
	1939	1940	1939 Spot	1939 3 mos.	1940 Spot	1940 3 mos.
January	4.500	5.644	13.682	13.887	(a)	(a)
February	4.500	5.534	13.522	13.780	(a)	(a)
March	4.500	5.750	13.728	13.961	(a)	(a)
April	4.500	5.750	13.443	13.637	(a)	(a)
May	4.500	5.803	13.717	13.938	(a)	(a)
June	4.500	6.235	14.023	14.223	(a)	(a)
July	4.516	6.250	14.235	14.435	(a)	(a)
August	4.719	6.389	14.628	14.761	(a)	(a)
September	6.104	6.920	(a)	(a)	(a)	(a)
October	6.500	7.250	(a)	(a)	(a)	(a)
November	6.500	7.250	(a)	(a)	(a)	(a)
December	5.980	.....	(a)	(a)	.....	.....
Year	5.110	.....	(b)13.872	(b)14.078	.....	.....

St. Louis quotations, Prime Western, cents per pound. London, pound sterling per long ton. (a) No quotations. (b) Average for eight months.

CADMIUM AND ALUMINUM

	Cadmium		Aluminum	
	1939 (a)	1940 (a)	1939	1940
January	58.400	79.038	20.000	20.000
February	55.000	80.000	20.000	20.000
March	54.259	80.000	20.000	19.769
April	50.000	80.000	20.000	19.000
May	50.000	80.000	20.000	19.000
June	50.000	80.000	20.000	19.000
July	50.000	80.000	20.000	19.000
August	53.704	80.000	20.000	18.000
September	64.200	80.000	20.000	18.000
October	74.600	80.000	20.000	18.000
November	75.000	80.000	20.000	17.522
December	75.000	.....	20.000	.....
Year	59.180	.....	20.000	.....

Aluminum in cents per pound, 99 plus per cent grade. Cadmium, cents per pound. (a) Producers' price, commercial sticks.

ANTIMONY, QUICKSILVER, AND PLATINUM

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1939	1940	1939	1940	1939	1940
January	11.670	14.000	77.440	156.962	34.440	40.000
February	11.250	14.000	85.227	178.000	35.000	40.000
March	11.269	14.000	87.278	180.921	35.000	40.000
April	11.500	14.000	90.800	173.538	35.000	38.923
May	11.712	14.000	86.769	181.538	35.000	38.000
June	12.000	14.000	86.615	197.360	35.000	38.000
July	12.000	14.000	86.960	194.423	35.000	38.000
August	12.000	14.000	84.407	184.111	35.333	38.000
September	12.910	14.000	140.000	173.333	40.080	36.167
October	14.000	14.000	145.600	168.846	41.120	36.000
November	14.000	14.000	134.978	168.391	40.000	36.000
December	14.000	.....	141.200	.....	40.000	.....
Year	12.359	.....	103.940	.....	36.748	.....

(a) Antimony, cents per pound, ordinary brands, in cases; in bulk 13.415 for November. (b) Quicksilver, dollars per flask of 76 lb. (c) Platinum, dollars per ounce troy.

PIG IRON

	Bessemer		Basic		No. 2 Foundry	
	1939	1940	1939	1940	1939	1940
January	21.50	23.50	20.50	22.50	21.00	23.00
February	21.50	23.50	20.50	22.50	21.00	23.00
March	21.50	23.50	20.50	22.50	21.00	23.00
April	21.50	23.50	20.50	22.50	21.00	23.00
May	21.50	23.50	20.50	22.50	21.00	23.00
June	21.50	23.50	20.50	22.50	21.00	23.00
July	21.50	23.50	20.50	22.50	21.00	23.00
August	21.50	23.50	20.50	22.50	21.00	23.00
September	22.50	23.50	21.50	22.50	22.00	23.00
October	23.50	23.50	22.50	22.50	23.00	23.00
November	23.50	23.50	22.50	22.50	23.00	23.00
December	23.50	.....	22.50	.....	23.00	.....
Year	22.083	.....	21.083	.....	21.583	.....

Iron, dollars per long ton. F.o.b. Mahoning and Chenango Valley furnaces

PERSONAL ITEMS

Expansion of *Engineering and Mining Journal* Editorial Activities and Staff

COINCIDENT with plans for celebrating its seventy-fifth anniversary in 1941, *Engineering and Mining Journal* has launched an expanded program of editorial activity designed to broaden its service and enhance its usefulness to new groups of readers. Prompt and efficient execution of the program is insured by the addition of two new editors to the staff, effective December 1, 1940.

WALTER M. DAKE

Walter M. Dake becomes managing editor of *Engineering and Mining Journal*. He joined the staff of *Engineering and Mining Journal* and *Coal Age* in 1936 as manager of research of McGraw-Hill's mining publications—a position in which he drew upon his broad experience as a consulting engineer and operator in both metal and coal mining. In 1939 he was made managing editor of *Coal Age* and now resumes his relationship with *Engineering and Mining Journal* in the same capacity. From 1903 to 1917 he was engaged in construction and operation at metal mines and reduction works in Colorado, Nevada, Oregon, California, Alaska, and Mexico. Among his more important connections were those with Goldfield Consolidated, Pittsburgh Silver Peak, United States Smelting, and Aurora Consolidated. Later he engaged in coal mining and became consulting engineer in charge of sales for the Joy Manufacturing Company, where for thirteen years he directed pioneer applications of mechanized mining methods throughout the United States and Europe. He is particularly interested in the mechanization of underground operations and will direct attention to that aspect of *Engineering and Mining Journal's* field.

J. H. Edwards fills a new rôle in *Engineering and Mining Journal's* editorial organization, that of electrical editor. His services are engaged in recognition of the growing use of electricity in metal-mining operations, marked by trends toward electrically operated equipment. He is a graduate electrical engineer, with broad experience in transportation, power plants, and mining. Since 1924 he has been associate editor of *Coal Age*. His special interest lies in problems of electrical and mechanical operation and maintenance, and he will reflect this important phase of mining activity in his contributions to *Engineering and Mining Journal*.

Management as well as electrical engineers, electricians, mechanical engineers, and master mechanics and their assistants who are engaged in metal and non-

J. H. EDWARDS

metallic mining operations will be beneficiaries of this new and expanded editorial program in *Engineering and Mining Journal*. It will immediately afford increased and continuous travel on the part of the editors, assuring all readers of prompt news of development in mining methods, metallurgical processes, and equipment for low-cost operation.

Simultaneously with these additions to the staff, H. C. Chellson has been promoted to associate editor.

Miles F. McDonald has succeeded the late A. L. Bailey as vice-president of the Butte Copper & Zinc Company at Butte, Mont.

C. E. Gregory has been appointed mine manager of Blue Spec Mines, N. L., Nullagine, Western Australia, in succession to **J. Nisbet Dods.**

C. Sewell Thomas, consulting mining engineer, Denver, Colo., was in New York in the latter part of November on professional business.

W. M. Morgan, formerly underground manager at Lake George Mines, Captain's Flat, New South Wales, has been appointed general manager of Adelong Gold Estates, N. L., Bright, Victoria.

W. C. Browning, general manager, Golden Queen Mining Company, Los Angeles, has been elected chairman of the Western Division of the American Mining Congress.

Jesse L. Maury, of The Lehman Corporation, New York City, has been appointed a member of the visiting committee for the department of geology of the Massachusetts Institute of Technology.

C. E. Nighman has joined the staff of the United States Bureau of Mines as senior mining engineer. He was until recently mineral economist in the General Land Office of the Department of the Interior.

D. Symons, recently on the staff of Electrolytic Zinc Company of Australasia, Ltd. at Rosebery, Tasmania, has been appointed chief assayer of Gold Mines of Kalgoorlie, Ltd., Kalgoorlie, W. A.

Frank S. Crawford, of Duluth, Minn., district engineer for the United States Bureau of Mines, has received notice that he is to be transferred to Phoenix, Ariz., as engineer in charge of the safety division.

P. C. Fedderson has been named general superintendent of the Bunker Hill & Sullivan smelter at Kellogg, Idaho, following the death of Alfred Beasley. **J. B. Schuettenhelm** has been advanced to superintendent.

Dr. H. Hirst, of the metallurgy department of the University of Melbourne, has been appointed technical adviser on non-ferrous metallurgy to the ordnance production section of the Australian Ministry of Munitions.

J. A. Paterson, formerly employed in northern Ontario and Quebec, has taken charge of operations for Bayonne Consolidated Mines, Ltd., operators of a producing gold mine in the Nelson mining division, and reports work well in hand, with prospects favorable.

Russell Fish, who has been chief engineer and assistant to **George Cannon** in the Iron River district of Michigan for the M. A. Hanna Company, has succeeded the late William E. Craig as general superintendent of the company's Minnesota operations. **Stephen E. Quayle,** superintendent of the Bates mine at Iron River, Mich., has been appointed general superintendent of the company's operations in Michigan, and **W. E. DeWald** has been appointed chief engineer of the Michigan operations. Mr. Quayle and

Mr. DeWald will reside at Iron River, Mich.

Julius H. Gillis, metallurgical engineer, recently returned to Sylva, N. C., following a business trip to New York.

Albert W. Hahn, consulting metallurgist, Balfour Building, San Francisco, Calif., was in New York recently on a business trip.

Adolfo Gunther, operator of Cia. Minera de Ancoccala, at Arequippa, and other mining properties in Peru, returned to South America on Dec. 6 following an extensive business visit in the United States.

Claire C. Balke has rejoined the research staff of Fansteel Metallurgical Corporation, North Chicago, Ill., to participate in studies in the powder metallurgy of tantalum, tungsten, columbium, molybdenum, other metals, and refractory metal carbides.

R. A. Karr, recently with the Battelle Memorial Institute and the central alloy division of the Republic Steel Company, has been appointed metallurgist at the new plant of Copperweld Steel Company at New Warren, Ohio.

Leon W. Dupuy has been appointed mining engineer with the United States Bureau of Mines. His headquarters will be at Tucson, Ariz., but his work will be in the field, helping to develop the national supply of strategic minerals.

Gordon H. Chambers, vice-president of the Foote Mineral Company, recently returned from an extended vacation to South America. Mr. Chambers visited Peru, Bolivia, Argentina, Brazil, Porto Rico, and Haiti. The entire trip of some 15,000 miles was made via the new Pan-American Airlines.

John A. Church, consulting mining engineer, New York, has been appointed to serve as zinc and copper specialist in the minerals division of the National Defense Advisory Commission. He began his work in Washington, D. C., in November.

J. C. Barton, of Reno, Nev., formerly Tri-State manager of the Kansas Explorations, Inc., a subsidiary of the St. Joseph Lead Company, has accepted a position as consulting mining engineer for the St. Louis Smelting & Refining Company, a subsidiary of the National Lead Company.

R. M. Hammell, formerly engineer for Tom Reed Gold Mines Company at Oatman, Ariz., before its shutdown, has been for some time with the Tombstone Mining Company as local manager and general superintendent at the Allison mine, 25 miles from Sells, Ariz. A cyanide plant with an ultimate capacity of from 50 to 100 tons is under construction.

Joseph C. Arundale, of Miami, Okla., has accepted a position as statistician for the Tri-State Zinc and Lead Ore Producers Association, in Picher. He succeeds **Edgar C. Long,** who resigned to accept a supervising position with the Baroid Sales Company, a subsidiary of the National Lead Company, with operations near Malvern, Ark.

Arthur F. Johnson, formerly manager of the Alice property of the American Smelting & Refining Company, has returned from the company's Big Bell Mine, Ltd., in West Australia, to take charge of the Silver Lake properties in Silver Lake Basin, Silverton.

This group of mining men went by plane, in the middle of November, into the Selway forest of central Idaho and each brought out one deer and one elk, the limit. They are, left to right, Carl Sheldon, Spokane; W. M. Yeaman, Yakima, manager Consolidated Mining Company; Frank Lilly, Spokane, mining statistician, who organized the hunt; Robert M. Hardy, Yakima, president Sunshine Mining Company; Croil Hunter, St. Paul, president Northwest Airlines Company, and Bert Zimmerly, Lewiston, pilot. The Selway is one of the most inaccessible districts in the United States.

Frank A. Crampton, mining engineer of Nevada City, Calif., has resigned as manager for the White Peak Mines, Inc., with a cinnabar property and furnace in the Bottle Creek district, in Humboldt County, Nev., and has assumed charge of the Blue Silver mine, at Barrett Springs, in the same county, making headquarters at Winnemucca, Nev.

Delmar Jones, formerly chief chemist for the Shenandoah Dives Mining Company, has taken a lease on the Anti-Periodic mine, in the Stont Pass area in San Juan County. He plans to construct the truck road from Cunningham Gulch to the mine and install a compressor and the mining machinery this year, for the development of mill ore. The mine has produced some high-grade smelting ore.

William O. Vanderburg, senior resident mining engineer in Nevada during the past twelve years for the United States Bureau of Mines, is in Washington, D. C., whence he will proceed to Peru and other South American countries, having been assigned to perform "important work for which he is specially fitted," according to a statement by the Bureau. He has been engaged in examination work in connection with the strategic minerals act.

Wilbur R. Varney has been appointed metallurgist to the Taylor-Wharton Iron & Steel Company, with plants at Easton, Pa., and High Bridge, N. J. He succeeds **Roy A. Gezelius.** Mr. Varney was graduated from Northwestern University in 1937, where he was a co-operative student four years with the metallurgical department of the Hunt-Spiller Manufacturing Corporation, of Boston. A graduate fellowship in metallurgy at the Rensselaer Polytechnic Institute led to a Master of Science Degree in 1938. For the past two years, Mr. Varney has been with the Bethlehem Steel Company.

J. Owen Ambler, metallurgical engineer, has returned to the United States from Turkey, where he was resident engineer at Murgul for the Eti Bank of Ankara. In connection with the beneficiation of a copper deposit near Murgul he was in charge of construction, and for a short time of operation, of a concentrator, smelter, mine plant, and hydro-electric station. He left Istanbul on Aug. 17, arriving in San Francisco Sept. 27 after a long trip via Odessa, Moscow, Vladivostok, Tsuruga, and Yokohama.

Errol MacBoyle, executive vice-president, Idaho Maryland Mines Corporation, Grass Valley, Calif., has been appointed chairman of the State Mining Board by Governor Olson. Other members of the board include **Leroy A. Palmer,** consulting engineer, San Francisco; **James E. Babcock,** Los Angeles mine operator; **Vincent Ryan,** Weaverville hydraulic mine operator, and **C. H. O'Rourke,** La Porte, Calif.

P. H. Reagan writes from La Paz, Bolivia, to point out an error in his article, "Bolivia for Strategic Minerals," as it appeared in the October issue. The caption of the photograph on page 54 showing the Milluni mill stated that it is "a property of the Hochschild group." Mr. Reagan says this is not correct. The statement cited was taken from *Foreign Minerals Quarterly,* Vol. 2, No. 4 entitled "Bolivia's Mineral Resources, Production and Trade," issued by the United States Bureau of Mines late in 1939. The error is regretted.

E. B. Green, president of The Cleveland-Cliffs Iron Company, Cleveland, Ohio, has announced that **Max H. Barber,** recently district superintendent of this company at Hibbing, Minn., will be promoted to the office of vice-president in charge of operations at Cleveland, Ohio; also that **W. A. Sterling,** in charge of the Canisteo mine at Coleraine, Minn., and the Holman-Cliffs mine, at Taconite, will be transferred to Hibbing, Minn., taking the place vacated by Mr. Barber. **H. C. Bolthouse,** superintendent of the Hill-Trumbull mine at Marble, Minn., will take over the Holman-Cliffs mine in addition to the Hill-Trumbull mine. **George E. Tucker,** of Hibbing, Minn., will

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become acting superintendent of the Canisteo mine at Coleraine, Minn. These appointments took effect on Dec. 1.

Dale L. Pitt left Western Australia in October to return to the United States. Mr. Pitt, who has held the position of general manager of Big Bell Gold Mines, Ltd., Big Bell, W. A., has directed all developmental and equipment work at the property since the inception of operations by the company.

E. A. "Bob" Montgomery, veteran Nevada miner and partner some 30 years ago of the late Charles M. Schwab in control of the Montgomery-Shoshone Mining Company at Rhyolite, Nev., has been reopening an old gold property at Masonic, Calif., and has taken options on two scheelite properties near Bishop and near the point where the United States Vanadium Corporation is constructing a 1,000-ton mill on Pine Creek in Inyo County, Calif.

John Robert Suman, vice-president of the Humble Oil & Refining Company, of Houston, Tex., was on Nov. 19 elected president of the A.I.M.E. for the year beginning in February, 1941, when he will assume the duties of that office. Two vice-presidents were also elected: **Paul D. Merica,** vice-president of International Nickel Company of Canada, Ltd., and **LeRoy Salsich,** president of Oliver Iron Mining Company, Duluth, Minn. **H. T. Hamilton** and **H. Y. Walker** were reelected directors and four new directors were also elected: **J. Terry Duce, Ira B. Jerolemon, J. R. Van Pelt, Jr.,** and **Clyde E. Williams.**

▼ ▼ ▼

OBITUARY

Walter Cecil Crawley, a partner in the firm of Henry Rogers, Sons & Company, dealers in non-ferrous metals, of London, England, died on Oct. 11.

Lewis Grote Beaumont, for many years chairman of the board of H. A. Watson & Company, Ltd., metal and mineral brokers, of Liverpool, England, died on Oct. 16.

S. L. Rawlings, well-known Bay area mining engineer, died recently at his home in Piedmont, Calif., aged 65.

Louis Goerne, widely known mining engineer in Mexico, died on Nov. 9 at his home in Mexico City, aged 70 years.

Nils Olaf Bagge, Swedish-born mining engineer and geologist, and for the last seven years manager of the Last Chance mine, at Mogollon, N. M., died on Nov. 17 at Silver City, in that State, at the age of 70.

William E. Ryan, mining engineer, educator, and long prominent in the activities of the national Democratic organization, died in Washington, D. C., on No. 5 at the age of 88.

Dr. C. O. G. Larcombe died on Sept. 9 at the age of 59. Formerly lecturer in geology, mineralogy, and petrology at the Kalgoorlie School of Mines, he resigned in 1934 to enter private practice.

Frederick C. Richmond, 77, organizer and president of the F. C. Richmond Machinery Company, died on Nov. 9. Mr. Richmond manager mining properties at Chihuahua, Mexico before coming to Salt Lake City in 1897. For three years, he was president of the Salt Lake Chamber of Commerce. He was also manager of the Delamar mill at Mercur, Utah.

John MacLaughlin, veteran mining man in Mexico, for long mill superintendent of the Cia. Minera Huitzuco, Huitzuco, Guerrero, died at Mexico City on Oct. 30. Mr. MacLaughlin was born in Brazil, Indiana, on May 8, 1873. He was a veteran of the first World War, in which he served with the United States Marines.

Key Pittman, who had represented the State of Nevada in the United States Senate since 1912, chairman of the important Foreign Relations Committee of the Senate since 1933, and for many years prominent in the councils of the Democratic party, died on Nov. 10 in Reno, Nev., at the age of 68. He had long been leader of the powerful silver bloc of the Senate and was a United States delegate to the Monetary and Economic Conference in London in 1933.

Ivan Ragaz, for long general manager of the Cia. Minera La Parreña, S. A., operating lead mines at Sierra Mojada, Coahuila, Mexico, died in Mexico City on Nov. 8. Mr. Ragaz, a native of Switzerland, came to Mexico 40 years ago and had spent all his time in this country in the mining industry. He was 70.

Thomas B. Crowe, metallurgical engineer, died on Nov. 13 at Palo Alto, Calif., where he had resided for the past seventeen years. Born in Emporia, Kan., he graduated from the Colorado School of Mines in 1900. His early mining experience was with the Ophelia Tunnel, the Cripple Creek, and the Portland Gold Mining Company, of Cripple Creek and Colorado Springs. In 1922 he became associated with the Merrill Company, mining engineers, of San Francisco. He was the inventor of the Crowe vacuum process and co-inventor of many other processes and apparatus used throughout the world.

▼ ▼ ▼

APPRECIATIONS

ALFRED FRANK BEASLEY

Alfred Frank Beasley, who died in San Francisco on Oct. 25, was affectionately known to his friends as "Al" Beasley. Accompanied by his wife he had gone to southern California about two weeks prior seeking relief from a long illness.

Mr. Beasley was born Feb. 12, 1886, in Peoria, Ill., as was his wife, Ruth (Elizabeth Gray), whom he met at the age of 16 and later married July 21, 1910, at Los Angeles. He received his technical schooling at Rensselaer Polytechnical Institute, Troy, N. Y. He began his metallurgical career by joining the staff of the Consolidated Mining & Smelting Company's smelter at Trail, B. C., in the fall of 1906, where he continued until April 1911, at which time he left to join the staff of the Mason Valley Mines Company at Thompson, Nev., where he remained about six years.

On June 18, 1917, Mr. Beasley arrived at Kellogg, Idaho, to join the staff of the Bunker Hill smelter, which was blown in seventeen days later. He was appointed assistant superintendent to the late M. H. Sullivan, and on the latter's death in February, 1928, he succeeded him as superintendent. On July 1, 1940, the company assigned a little broader responsibilities to the plant superintendent, and Mr. Beasley became general superintendent.

Mr. Beasley achieved a high plane in the metallurgical profession, and was a valuable friend to all who knew him and had his confidence. He is survived by his wife and two sons, Jules, and Alfred G., Jr.

W. Earl Greenough

NICHOLAS COLLINS SHERIDAN

The passing of Nicholas Collins Sheridan on Oct. 17, 1940, brings to a close the splendid story of a man who spent his life in the advancement of ethical and legitimate mining enterprise.

Born in San Francisco July 24, 1877, of Irish-American parentage, Mr. Sheridan, despite the early necessity of helping his family, decided upon mining engineering as his goal, and shortly before the turn of the century enrolled in that curriculum at the University of Idaho.

During summer vacations he worked in the Bunker Hill, the Morning, and various other Coeur d'Alene mines, and soon decided upon this region as his sphere of activity. Settling in Mullan, Idaho, he accepted a position as engineer of the old Snowstorm mine and contributed to the early successes of this undertaking. Sheridan left the Snowstorm to become manager of the Portland Canal mine, at Stewart, B. C., and from there to private mining endeavors in the Leadore district of Idaho.

Gaining experience and reputation, he was successively manager of the Success Mine, the Interstate Callahan, the Rex (old 16 to 1), and a number of other early productive properties.

In the 1920's he turned again to private enterprise, and conducted highly successful leasing operations on a number of properties throughout the district.

In 1922 Sheridan sold the Midnight mine to the Federal Mining & Smelting Company and secured a lease from this company on the upper workings of the Morning mine. The "Sheridan Lease," as this undertaking was known, became one of the major producers of the Coeur d' Alene district, and in six years produced four and one half million dollars' worth of lead, silver, and zinc.

He was instrumental in the organization and operation of the Golconda mine, the Columbian River Copper, the Black Bear and numerous other properties. The name of Nick Sheridan is symbolic—as perhaps none other—of the sincere and straightforward side of productive mining enterprise. His goal was metal rather than money. His work was his life, and he was proud of that work—proud that he had chosen one of the finest and cleanest of professions—productive mining.

Max Sheridan

What Metal Statistics Show

PRODUCERS of copper, lead, and zinc believe mine production in the United States is close to a capacity circumscribed only by present metal prices, which apparently the government views as satisfactory. Statistics show the increased demand for metal by consumers for the national defense program.

The duty-free copper statistics of the Copper Institute for the first 10 months of 1940, in tons, follow:

	Production (a) Crude	Refined
January	89,598	80,501
February	76,145	82,761
March	85,796	86,295
April	84,366	80,964
May	82,682	86,029
June	79,845	86,077
July	79,327	90,995
August	79,967	80,851
September	(b) 78,238	82,843
October	86,594	83,076
Totals	822,558	840,392

	Deliveries to Customers: Domestic	Export	Totals
January	91,428	13,117	104,545
February	63,215	9,594	72,809
March	64,376	7,517	71,893
April	68,665	2,974	71,639
May	69,467	7,018	76,485
June	61,716	3,439	65,155
July	71,226	3,532	74,758
August	96,383	(b) 1,336	(b) 97,719
September	96,485	....	(b) 96,485
October	103,771	....	103,771
Totals	786,732	48,527	835,259

	(c) Refined Stocks End of Month
January	135,441
February	145,393
March	159,795
April	169,120
May	178,664
June	199,586
July	215,823
August	(b) 198,955
September	185,313
October	164,618

(a) Mine or smelter production or shipments, and custom intake including scrap. (b) Corrected. (c) At refineries, on consignment and in Exchange warehouses, but not including consumers' stocks at their plants or warehouses.

Monthly sales of copper by producers for delivery to United States consumers, in short tons, follow:

	1939	1940
January	15,399	24,987
February	23,361	147,112
March	28,618	20,305
April	59,874	41,701
May	59,026	83,879
June	66,786	110,453
July	183,151	58,577
August	38,299	67,632
September	183,877	254,277
October	68,423	125,531
November	51,639	85,004
December	28,798	.....
Total	807,242	.....

Exports of refined copper (foreign copper refined in bond plus some domestic metal) during the first nine months of 1939 and 1940, by countries of destination, in short tons, were as follows:

To:	Jan.-Sept. 1939	1940
Mexico	955	2,522
Argentina	247	3,300
Brazil	1,835	3,913
Belgium	5,114	1,183
Denmark	897	560
France	57,313	30,404
Germany	21,283	.....
Great Britain	20,885	64,232
Hungary	687	4,442
Italy	21,815	33,837
Netherlands	4,177	3,198
Norway	1,152	65
Poland and Danzig	12,759	.....
Rumania	56	2,593
Russia	.....	54,477
Sweden	17,272	6,035
Switzerland	561	6,828
China and Hongkong	381	2,254
Japan	82,527	77,235
Kwantung	1,658	230
British India	1,590	350
Iran (Persia)	.....	1,063
Africa	205	169
Elsewhere	6,825	2,713
Totals	260,194	301,603

▶ ZINC—The October and November statistics of the American Zinc Institute, covering all grades, are summarized as follows in tons:

	Oct.	Nov.
Stock at beginning	30,965	22,600
Production	56,422	58,481
Production, daily rate	1,820	1,883
Shipments	(a) 64,787	(b) 61,145
Stock at end	22,600	17,936
Unfilled orders	116,420	126,120

(a) Includes 280 tons exported.
(b) Includes 560 tons exported.

Figures on operations of the Prime Western division alone, for the first eleven months of the year (January to November revised), in tons, follow:

	Production	Shipments	Stock At End
January	19,930	25,240	24,742
February	22,542	20,017	27,267
March	23,846	20,401	30,712
April	21,742	20,034	32,420
May	21,173	24,292	29,301
June	19,302	23,143	25,460
July	20,698	26,139	20,019
August	21,224	27,774	13,469
September	22,873	28,986	7,356
October	24,166	26,425	5,097
November	24,793	23,753	6,137

▶ LEAD—Total production of refined lead in the United States during October was 56,600 tons, of which 39,228 tons was produced from domestic ore and 17,372 tons from foreign ore and secondary metal smelted in connection with ore.

The refined-lead statistics for September and October, in tons, follow:

	Sept.	Oct.
Stock at beginning	43,321	41,292
Production:		
From domestic ore	41,528	39,228
Foreign and secondary	9,913	17,372
Totals	51,441	56,600
Domestic shipments	53,456	62,496
Stock at end	41,292	35,386

Shipments of refined lead to domestic consumers, in tons, by months:

	1939	1940
January	40,189	39,875
February	34,421	39,176
March	40,871	46,353
April	37,903	46,496
May	40,124	46,919
June	38,710	49,904
July	42,636	52,560
August	45,025	51,643
September	59,889	53,456
October	66,060	62,496
November	64,365	.....
December	44,881	.....
Total	555,074	.....

United States Zinc Supply

(American Bureau of Metal Statistics)

In Short Tons

	Monthly Average 1939	Jan.-June 1940	July 1940	Aug. 1940	Sept. 1940
Shipments reported by A. Z. I. (a)	49,914	310,468	55,896	61,130	62,801
Imports of foreign spelter	2,619	7,670	.....	3,359	477
Imports of foreign ore (b)	2,557	51,847	12,389	24,785	20,275
Estimated use for dip galvanizing	22,401	118,300	23,400	26,300	26,600
Estimated use for brass making	14,558	95,500	15,800	22,200	26,800
Exports of slab zinc	376	31,450	8,572	12,122	12,155
Exports of rolled zinc	535	3,463	951	557	522
Exports of zinc dust	236	1,435	350	246	259
Exports of galvanized wares (c)	1,242	11,400	1,900	2,000	1,900
Total exports	2,389	47,748	6,773	14,925	14,836

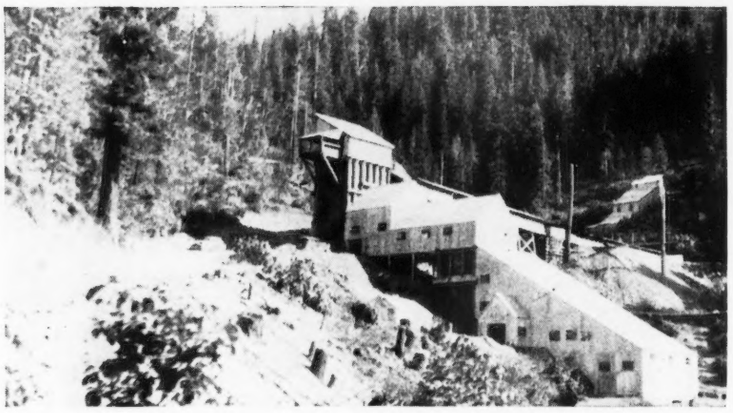
(a) Domestic deliveries as reported by American Zinc Institute. (b) Zinc content of ore at 85 per cent. (c) Estimated zinc tonnage used in coating galvanized wares.

E & M J Weighted Index of Non-Ferrous Metal Prices

(100 is composite for 1922–3–4)

1929	110.33	1934	69.59
1930	82.87	1935	74.66
1931	60.20	1936	73.45
1932	48.26	1937	90.86
1933	59.79	1938	73.67
		1939	77.71

	1938	1939	1940
January	75.56	77.12	80.85
February	73.43	76.89	77.23
March	72.41	77.09	77.94
April	71.19	74.79	77.19
May	69.15	73.61	77.68
June	67.55	73.17	78.85
July	72.95	71.95	76.72
August	73.94	73.88	76.71
September	74.70	83.07	79.40
October	77.61	84.25	82.49
November	78.36	83.80	83.14
December	77.13	82.89	....



View of 250-ton flotation plant of the Standart gold mines of the Indian Valley Mining Company, near Greenville, Plumas County, Calif.

CALIFORNIA

Production Started at New Almaden Mine

Quicksilver property being exploited by diesel shovels in open-pit operations—Surcease mine increases mill capacity—Plant at Kelsey mine to be enlarged

▶ Production has been started at the New Almaden quicksilver mine, about 12 miles from San Jose, Santa Clara County, which has recently been reopened by New Almaden Corporation, controlled by Philadelphia interests. The 5x60-ft. rotary furnace is currently handling ore mined from open pits, and operations are proceeding satisfactorily. Mining equipment includes two ¾-yd. diesel shovels, four large dump trucks, and a bulldozer. The furnace is oil-fired, and electric power is obtained from the P.G.&E. line completed recently. Operations are directed by C. N. Schuette, general manager, 74 New Montgomery St., San Francisco.

▶ The Surcease mine, about 20 miles northeast of Oroville, Butte County, and operated by Hoefling Brothers, of Sacramento, is again producing after a brief shutdown during which the mill capacity was increased from 85 tons to 150 tons by installation of new grinding and concentrating equipment, and a concentrate treatment plant has been constructed. Mining operations proceeded without interruption. Allan E. Jones, general manager, is in charge of operations.

▶ The development and rehabilitation work started a few months ago by the California Aztec Mining Company at the River Hill, Poverty Point, and Kelsey properties north of Placerville, El Dorado County, is proceeding according to schedule and results obtained so far are up to expectations. At the Kelsey unit a winze has been sunk from the lower tunnel to the 120-ft. level and drifting on the gold vein is under way. The raise driven at a point about 900 ft. from the tunnel portal and drifting on the upper tunnel level have opened an additional tonnage of good ore. Operations at the Kelsey mill are conducted on a three-shift basis following renovation of the plant, the capacity of which has been raised to 75 tons by addition of new flotation equipment. Plans have been completed to increase the size of the mill to 300 tons by March 1, 1941. Construction of a new tailings dam and of engineering and assay offices has been completed. At the River Hill unit the drainage tunnel has been cleaned out as a preliminary to actual development, and at the Poverty Point unit the New York shaft is being unwatered, with production scheduled to start in about a month. Ex-Senator Tasker L. Oddie is president of the company, and Malcolm H. Carpenter is executive vice-president and general manager. The company maintains offices in the Balfour Building, San Francisco.

▶ Construction of a 75-ton Gould quicksilver reduction plant is rapidly nearing completion at the property of the recently organized Panoche Quicksilver Mining Company, of San Francisco, and production is expected to be started early in December. The mine is some 42 miles south of Hollister, San Benito County, and was discovered about a year ago by Louis Sciochetti and George Valdez, of Hollister. Directors of the company include J. R. Wilson, H. R. Cossitt, A. R. Swanson, G. Goszulak, and William F. Rose, and offices are maintained in the Mills Building, San Francisco.

▶ Examination of the Wieland mine, near Jackson, Amador County, following completion of dewatering operations, is being made by the American Smelting & Refining Company under the direction of J. Fred Johnson, manager, Western mining department, Salt Lake City, Utah. The property was reopened about a year ago by Wieland's Mine, Inc., after nearly 40 years of idleness. James Wilson is resident superintendent.

▶ Milling operations have been resumed at the Pennsylvania mine, Browns Valley, Yuba County, where a 125-ton flotation mill has been completed recently. The new unit replaces the 50-ton mill formerly used, and also handles ore trucked in from the neighboring Dannebroge mine. Both properties are operated by Empire Star Mines Company, Ltd., and managed by Robert J. Hendricks, of Nevada City. At the company's North Star property, J. R. C. Mann, manager, a new headframe and ore bins are under construction.

▶ Gold Hill Dredging Company, E. B. DeGolia, president, San Francisco, has started operations on placer ground near Clements, San Joaquin County, with the modernized bucket dredge unit operated for several years in the Loomis area. M. L. Summers is general superintendent, and N. Stetler, dredgemaster.

▶ Dump material and ore mined underground are treated in the reduction plant started up recently at the Knoxville quicksilver mine, near Monticello, Napa County, operated by George E. Gamble and W. V. Wilson, of Palo Alto. Work completed after reopening of the property included construction of camp buildings, installation of mining machinery, some of which was brought in from the Kenton mine, in Sierra County, once operated by Gamble, and a power line. About 43 men are employed under the direction of T. S. Scribner, superintendent.

▶ Arrangement to ship some 100 tons of lead-silver ore to the Midvale smelter of United States Smelting, Refining & Mining Company at Midvale, Utah, has been completed by Imperial Smelting & Refining Company, operators of the Darwin mine, in Inyo County, optioned recently from the Wagner Assets Realization Corporation, of New York City. S. B. Mosher is president of Imperial Smelting, and J. D. Williams, superintendent, is in charge of operations. About 45 men are employed.

▶ Loomis Mining Company has started mining operations at its property on Yankee Hill, two miles southeast of Loomis, Placer County, formerly worked by hydraulic methods. Current work follows close to that employed at drift-gravel mines, the mined gravel being transported to the stationary washing plant near the mine by dump trucks through a 14x15-ft. tunnel opened by a special digging unit.

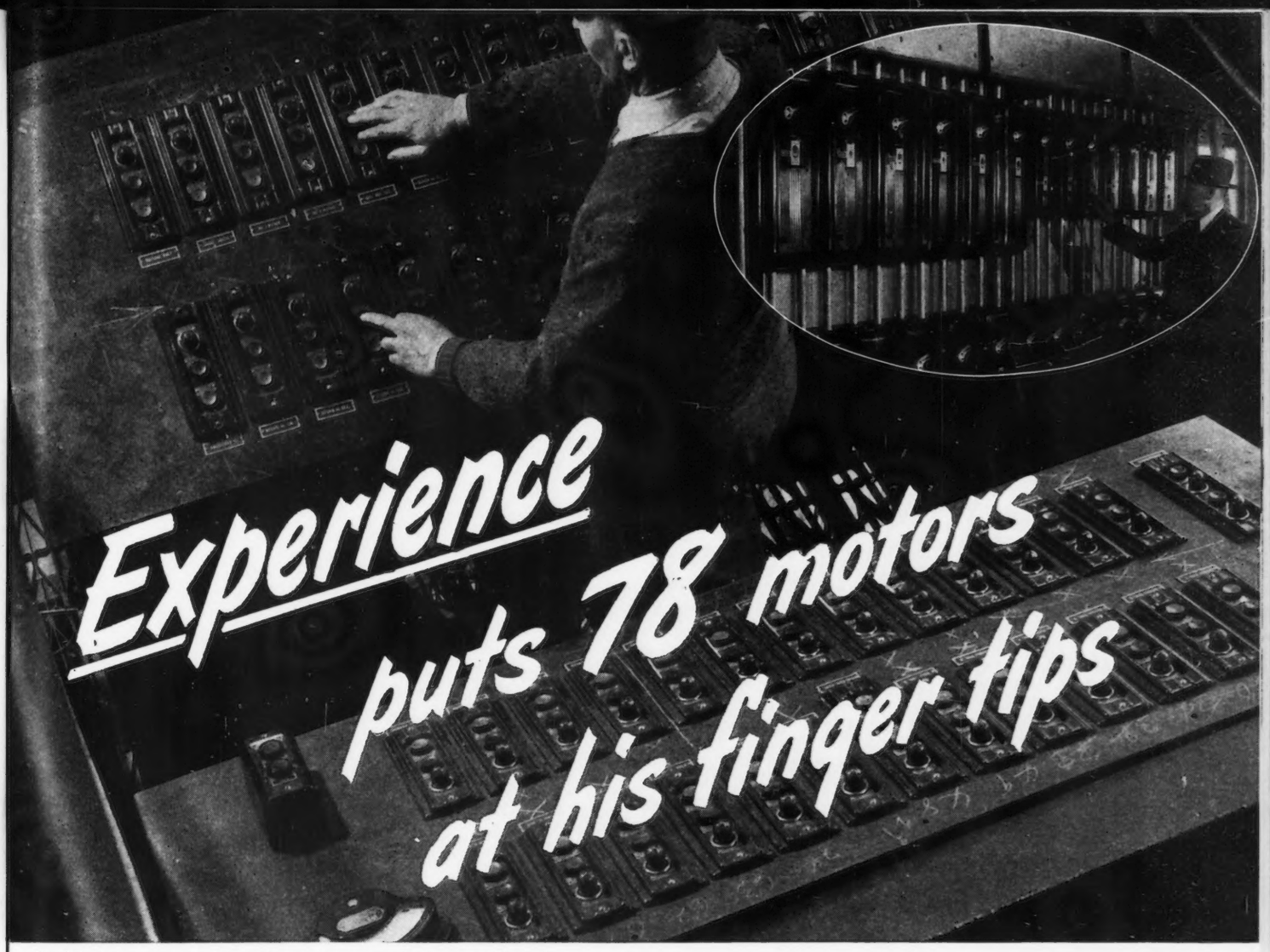
IDAHO

Calyx Drill Hole Being Sunk in Morning Mine

Ventilation to be improved through circular underground shaft—Polaris mine will receive deep development through Sunshine property

▶ A Calyx drill has been installed at the Morning mine on the 4,100 level to drill a 3-ft. diameter hole to the lower level for air circulation. The oreshoot on the 4,050 level is reported to be 615 ft. in length and developed ore reserves in the mine at the end of 1939 were estimated at 960,000 tons. Page mine is now treating 400 tons of ore daily and has a reserve of 405,000 tons. A new electric hoist capable of reaching 5,000 ft. was recently installed.

▶ Polaris Mining Company, adjoining the Sunshine, will gain 1,400 ft. addi-



Push button control at a midwestern mine, which works through combination circuit breakers and linestarters shown in inset.

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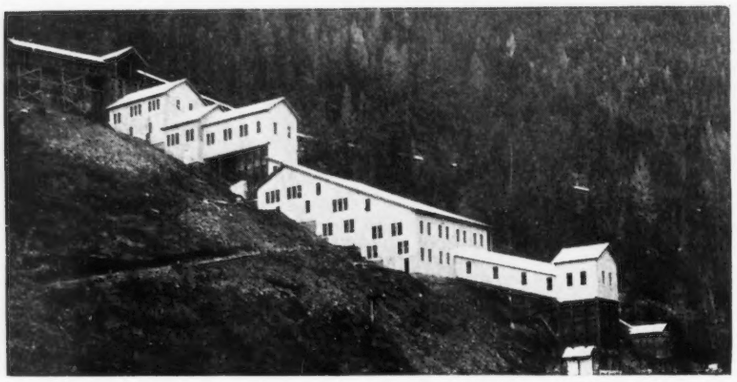


Coeur d'Alene Mines Corporation's new 300-ton all-flotation milling plant at the mouth of McFarren Gulch, 4 miles west of Wallace, Idaho, which started operations in November. Capacity may be stepped up to 600 tons in 1941 and eventually to 900 tons daily

▶IDAHO

tional depth on its oreshoot as a result of new development work under way from the 2,700 level of the Sunshine shaft, according to L. E. Hanley, Polaris president, of Wallace. Polaris and Sunshine are jointly interested in a block of ground between the two properties. Polaris has 60 per cent and Sunshine has 40 per cent in the upper portion, with the interests reversed in the lower portion. Polaris employs 113 men.

▶Highland-Surprise Mining Company, operating in the Pine Creek district, has unwatered two shafts and expects to be producing lead-zinc ore by Jan. 1. Mill tests show a feed of 12 per cent zinc and 5 per cent lead which concentrates into 52 per cent zinc and 49 per cent lead. When in full operation the company will employ about 60 men. Dr. Charles R. Mowery, of Spokane, is president.

▶Sunshine and Metropolitan Mining companies, owning adjoining property, have completed an agreement whereby Sunshine will drive a crosscut from its 3,100 deep shaft level to prospect Metropolitan ground, according to Roy H. Kingsbury, of Wallace, Metropolitan secretary. Ore encountered in the 3,200-ft. drive will be divided on a percentage basis.

▶Mineral Mountain Mining Company is installing machinery for deeper development work at its property in the Coeur d'Alene silver belt adjoining the Polaris. The shaft will be sunk from the 300 to the 600 level. R. S. Merriam, Wallace mining engineer, is manager.

▶Gold dredge placer operations in Idaho County during 1940 will swell that district's gold output to around $1,250,000, according to Walter Hovey Hill, veteran Grangeville engineer. Nine dredges are now operating on gravel deposits made workable by new improvements in dredge machinery. Quartz mining is also booming, both the Center Star and Penman mines having modern flotation mills in operation. C. C. Samuels, former manager of the Sunshine mine, is directing the Penman. Concentrates are trucked to the Bunker Hill smelter at Kellogg.

▶Federal Mining & Smelting Company reports profits of $238,765 for the last quarter of 1940 before depletion and Federal income tax deductions. Operations in the Coeur d'Alenes are at the Morning and You Like mines at Mullan and the Page and Black Hawk mines near Kellogg.

▶Silver Dollar Mining Company, operating in the silver belt, recently broke into a 35-ft. vein on the 2,500-ft. level, 400 ft. below present mining operations. On the footwall side a 5-ft. vein with stringers of silver-copper carrying 100 oz. silver per ton was exposed.

▶Silver Crescent Mining Company, owner of the Charles Dickens mine, in the Coeur d'Alenes, is developing a gold property near the Canadian boundary in the northeast corner of Idaho. A shaft is being sunk on $40 a ton gold ore. A 100-ton flotation mill is planned as sufficient tonnage is developed.

▶Operations were started in November at the old Horn Silver property, near Fairfield, in southern Idaho, by W. O. Stubblefield and E. F. Stratton, both of Fairfield. New equipment was installed and ore is being mined from a new vein which assays as high as 200 oz. silver and 17 per cent lead. Shipments will be made as long as weather permits.

▶Three large silver-lead producers of the Coeur d'Alene district, Bunker Hill & Sullivan, Sunshine, and Hecla, have declared fourth quarter dividends amounting to a grand total of $1,172,528. Bunker Hill will pay $327,000, bringing the total paid this year to $1,308,000 against $981,000 in 1939. Sunshine Mining Company will pay $595,528, making a total paid this year of $2,382,112, the largest disbursement made by any mine in the Coeur d'Alenes or by any other single mine in the United States for a similar period. Operations are being conducted 400 ft. below sea level and the mine is being opened to 1,000 ft. below sea level, where the temperature is 95 deg. F. Approximately $100,000 has been expended for ventilating equipment. Hecla Mining Company will divide $250,000 among its stockholders, making the total paid this year $600,000. The company is driving a long crosscut from the 3,400 shaft level to open the Omaha group of claims. Hecla is also operating the Polaris and the Atlas mines.

ARIZONA

Mercury Deposits Being Developed

Small production started from property near Mesa—Brighter Days Mining Company cuts gold-silver-lead vein

▶Brighter Days Mining Company, operating the Samoa group of claims east of Chloride, recently cut the Samoa vein with its crosscut tunnel at a depth of 700 ft. and 400 ft. below the bottom of the old shaft. The vein where cut by the crosscut shows about 7 ft. of ore of good commercial grade. Difting on the gold-silver-lead vein is now in progress. It is planned to advance the crosscut several hundred feet to cut another vein whose surface development indicates commercial ore. George Mitchell is manager.

▶R. E. Tabor and E. M. Leonard, officials of the Gold Cliff Central Mining Company, operating the mill at the Little Golconda, have taken a lease and option on the old Towne base-metal mine, near Chloride, and are unwatering the shaft preparatory to making an examination.

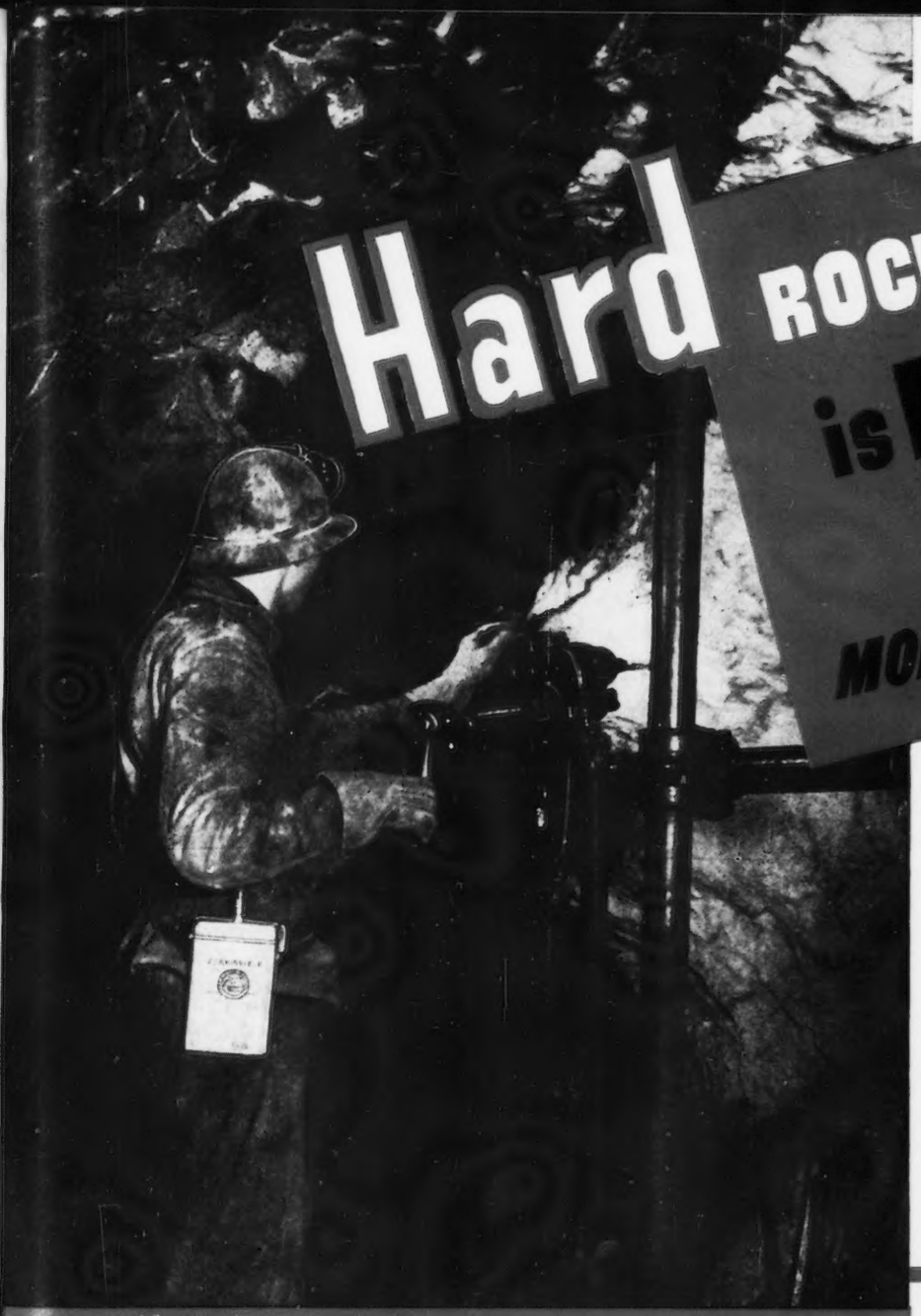
▶Norman W. McGregor, of Aguila, is developing a manganese property in the Artillery Peak section of Mohave County and recently shipped his first carload of manganese ore to the American Manganese Corporation, Los Angeles, Calif. The ore assays about 40 per cent manganese. It is hauled by truck to Wenden, a station of the Phoenix branch of the Santa Fe Railroad.

▶The first flask of mercury was produced in late October from the Maricopa mercury property, in the Sunflower district near Mesa. The property is operated by Chris Klein and Earl Conway, of Mesa. Six men are employed. The property is owned by Chris Martin, of Mesa.

▶Tuscarora Gold Mine Company has taken over eleven claims near Octave. A 50-ton mill employing concentration, amalgamation, and flotation has been erected. Ralph Roseberry, Room 662, 124 West Fourth St., Los Angeles, Calif., is general manager. T. A. Barkley is in charge of operations at the mine.

▶Secret Pass Mines, Inc., R. C. Ferguson, Box 226, Kingman, Ariz., superintendent, has a crew of eight men developing the property. Plans for a mill are being made. Meanwhile selected ore is expected to be shipped to a custom mill for treatment. J. T. MacEvoy, 50 Broadway, New York City, N. Y., is manager of the company.

▶A new 125-hp. Waukesha power unit has been installed on the Ord mercury property, on Slate Creek near Tonto Basin. Recent development has disclosed additional reserves of cinnabar ore. Mining is on a two-shift basis, with the furnace in constant operation. L. E. Foster, Box 776, Phoenix, Ariz., is general manager. W. V. Ranney, Route 1, Box 32, Highland, Calif., is owner of the property.



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NEWS FROM Washington

By Special Correspondent

DEFENSE PLANNING has reached the slow, less spectacular stage. Most of the big orders have been placed. Getting ready for actual production is going on. The inadequacies of previous years' planning are thus in the spotlight. But Washington does not seem unduly discouraged, since the British fleet still controls the Atlantic.

Perhaps labor problems are more serious than any others affecting this matter, in the mind of official Washington. One of the great unanswered questions is "Will the public stand for strikes in defense industries?" Most officials think not. But how to mechanize some plan that will give labor the maximum protection without producing interruptions due to strikes is a very serious problem, on which officials are working diligently but not too hopefully.

Copper From Abroad

THE COPPER REQUIREMENTS of the United States for 1941, including both civilian and defense needs, are estimated at 1,200,000 tons. Domestic production will, it is expected, readily provide about 90 per cent of this supply. The last 10 per cent will undoubtedly come from abroad, mainly from Chile. Officials hesitate to promulgate this decision because it is bound to stir a new mining industry controversy. But as early as mid-November the plans to this effect were rather definitely formulated.

Government specialists believe that 6 or 7 per cent of the required 10 per cent above normal production could be had from small producing units. But to make such operations profitable it is estimated that the price of copper would have to be 16c. to 17c. Defense planners have no intention of permitting such an advance in price. They intend to bring in foreign copper, or see that it is brought in, so that the price will be stabilized at or near 12c. Again this is not official, but it is none the less real as the November plans are formulated.

The government is hesitant at this time to encourage increases in capacity of present large copper properties. Responsible officials feel that enlargement of facilities for either mining or smelting might be merely an invitation to uneconomic properties when the post-emergency period begins. Even if the government were willing to subsidize such new capacity with present large producers who might expand at present copper price levels, they think it bad both for Uncle Sam and for the industry.

Not a negligible consideration which has led to this decision is that purchase of Chilean copper will greatly strengthen hemisphere arrangements. The State Department and the President are of course very anxious to have any such opportunity for Latin American "appeasement." When it will result in saving money for Uncle Sam, such a proposal is doubly welcome.

The Value of Gold

FREQUENTLY RECURRING in Washington is talk about the post-emergency status of gold. On one side are those who argue "gold will be worthless." Those at the other extreme say "control of gold gives control of world exchange."

Despite all this argument there are two sure facts on which the mining industry can count.

1. Uncle Sam will continue to buy all the gold from domestic sources and there is no danger of any cut in the price. In fact, neither faction engaged in the gold argument even speculates as to whether domestic virgin gold will be so bought; it is taken for granted.

2. The United States will continue to buy all of the foreign gold offered, and at the present or even *possibly* at a higher price. This is necessary to help Britain. The Roosevelt administration can, by purchase of imported gold, which comes mainly from the British Empire and its friends, extend greater credits to our friends than would otherwise be legally possible under the Johnson Act.

In view of these two apparently fixed conclusions, most of the recently recurring controversies have no point with respect to immediate plans for the sale of gold to the United States Government. But neither of these arguments has any bearing on what will happen to gold after the emergency. The astrologers are probably as reliable a source of forecast on that subject as anyone else.

Defense Amortization

A DEFINITE PROGRAM has been worked out by the Defense Commission, and the Army, Navy, and Treasury officials, under which the amortization provisions of the tax law will be applied. Any mining, smelting, or other industrial enterprise wishing to take advantage of the five-year amortization program, instead of the longer normal period for depreciation charges, must get a "necessity certificate." Full instructions have been prepared as to the procedure for making application and prosecuting such cases. This information can be had from the Treasury Department on request.

If a miner is being reimbursed by the government for his output in any other than a fixed-price competitive-bid contract, added complications are involved in using rapid amortization plans. It is necessary under such circumstances that the firm interested secure either a "certificate of non-reimbursement" or a suitable form of "certificate of government protection." The purpose of these is to make sure that the government does not allow large deductions from the tax bill and at the same time make "double" reimbursement to the industry.

These matters are of considerable concern to any firm that is engaged primarily in supplying mineral or metal to the government from facilities that have been expanded particularly for this purpose.

Ore Treatment in Trade Zones

CONTROVERSY HAS ARISEN over what sort of ore dressing or beneficiation may be accomplished by the owner of mineral substances while they are held in duty-free status in the foreign trade zones. The law provides that such goods may be repackaged or subjected to some other types of handling. But the law also forbids definitely manufacture or refining of goods while so held.

Recently the Bureau of Customs ruled that "a processing of ore which segregates therefrom a part of the nonmetallic substances without any change in the native character of the metallic elements is not a manufacturing process and may be done in the foreign trade zone, or under the provisions of Section 562 of the Tariff Act of 1930, as amended."

The executive secretary of the Foreign Trade Zones Board has recently taken occasion to emphasize this ruling to the industry and to the press. The purpose is to refute the claims of warehousemen who objected to such processing of tungsten ore while it was stored in the New York Foreign Trade Zone. How far this ruling will be carried with respect to other minerals or metalliferous ores is not evident. That issue apparently has not yet arisen for official ruling.

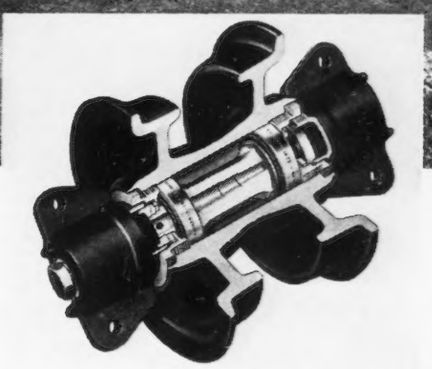
Debt Limit and Taxes

TWO DAYS AFTER election Secretary of the Treasury Morgenthau announced that he was going to request Congress in January to authorize increase in the public debt limit to $60,000,000,000 or $65,000,000,000. The present limit is $45,000,000,000 with a special proviso for a short-term increase of $4,000,000,000 additional. The Secretary indicates that the higher debt limit suggested by him will be necessary even though large increases in taxes are levied soon.

Even before Congress convenes for the next session in January there will be numerous quasi-official discussions as to where those taxes will be imposed. Almost certain is an increase in both the normal and the surtax rates on individual incomes. Further increase on corporation income taxes is not expected soon, since they were quite recently raised to 24 per cent. Special corporation taxes including excise levies on certain commodities are, however, almost certain.

The date which such taxes may become effective is, of course, merely a matter of speculation at this early time. But it is not believed that anything more than increased rates on individual incomes can be enacted soon enough to be retroactive as to any 1940 business. Even those increases may not be so levied.

Increased activity of business and renewed employment for large numbers of workers will, it is expected, provide something between $500,000,000 and $1,000,000,000 of additional income in the next calendar year as compared with 1940. New levies to add another billion per year are desired by the Treasury. Even then the deficits during the defense preparation period will be of the



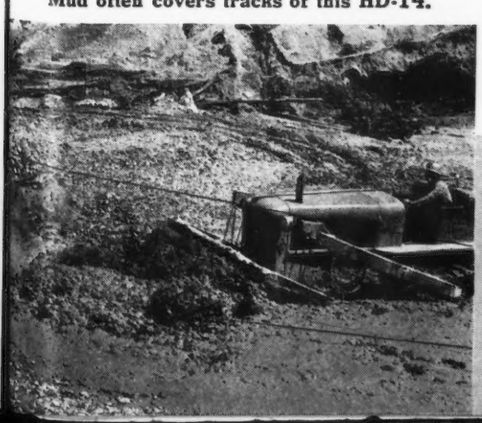
MUD SEALED OUT OF TRUCK WHEEL ASSEMBLY—Positive-Seal Truck Wheels keep mud out ... keep oil in ... require lubrication only once every 200 hours. An exclusive Allis-Chalmers feature ... especially ideal for conditions like this. Note pool of mud in which Poverty Hill's HD-14 is working.

WHAT THEY'RE DOIN' UP POVERTY HILL WAY

A Story of Four Mining Partners and How They Stepped Up Production

HD-14's and scrapers strip 80 feet to uncover heart of the rich lode.

Mud often covers tracks of this HD-14.



GOLD runs 100 feet deep at Poverty Hill Mining Company, California—a placer-hydraulic operation owned by four partners. But 90% of it is in the bottom 10 or 15 feet. Mining the whole bank was tried—all material was washed into grizzlies. It proved to be too slow . . . and unprofitable.

The partners then decided to strip the top 80 feet . . . quickest way possible! Contractor J. N. Tedford, Fallon, Nevada was called in. His three powerful, fast-moving Allis-Chalmers HD-14's took over. Two pulled scrapers—one operated as a pusher. Moved 405,000 yards from June to November—averaged 40,500 yards per scraper each month.

The partners took note of the fast dirtmovers. Decided it would pay them to have an HD-14, with a bull-dozer, to push the material up to their monitors instead of reaching out with the monitors alone. Plan worked to perfection.

Now production is way up . . . profits are rolling in . . . partners are enthusiastic over the way their idea clicked.

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order of five to six billion dollars annually. During peak spending Uncle Sam will be disbursing in excess of one billion dollars per month, even assuming no "shooting war."

Stockpile Troubles

GOVERNMENT STOCKPILES of strategic minerals have not grown during the last month as rapidly as the planners hoped. Perhaps one of the greatest difficulties has been the delay in deliveries incident to shortage in shipping capacity. The Navy has been buying ships. Many vessels have had to be transferred to unusual runs. The presence of U-boats and the German raiders in the Atlantic have not increased the ease of movement of goods, even those which come from Africa. Altogether, the progress on stockpiles is more contingent on these factors than on anything else.

Uncle Sam has proceeded to commit all of the available $60,000,000 specifically appropriated for strategic stockpile building. Some of the commitments are for goods that probably can never be delivered. Such moneys will later be transferred for other purchases. In the meantime, however, there are plenty of other special funds which can be utilized as required whenever there is any reasonable certainty of delivery. Congress has kept appropriations sufficiently flexible to make these business transactions prompt and easy so far as needed money is concerned.

Tin imports in September made an all-time record by exceeding 14,000 tons. However, the government stockpile did not grow, as most of the imports were taken promptly by industry. Further deliveries to the stockpile are not expected so long as tin is above 50c. a pound. That is the maximum price which the government expects to pay under present circumstances. Incidentally, this is not a serious practical question, because all of the tin which comes in is promptly taken up and the government is quite as happy to have the metal in private stockpiles as under government control.

More tungsten for stockpile purposes has been ordered from China. But whether the additional $10,000,000 worth can be delivered depends both on conditions along the Burma Road and on freighter capacity for movement from the Orient. This $10,000,000 worth is in addition to the $30,000,000 worth previously contracted for, as explained in this column during earlier months.

News "Fines"

Mining-State Bloc—The death of Senator Pittman and the failure of Senator Ashurst to be renominated leaves the Western States bloc in the Senate rather sadly disorganized. That group has been the most potent "pressure group" in Congress. In its effectiveness it has far exceeded the labor, the farm, and the other groups. It is the one group that has constantly won its battles with the President. An entirely new organization of the group is going to be necessary in January if this record of effectiveness is to continue.

Tax-Free Imports—Someone has discovered an old World War law which would permit the government to buy raw materials imported free of duty. That detail is not particularly important except when limited appropriations are involved. Payment of the duty represents merely a bookkeeping transaction so far as the net cost of defense is concerned. It is doubtful whether this old law would apply in any event to the excise tax on imported copper, since that is not strictly speaking a tariff.

New Labor Board—Appointment of Harry A. Millis as chairman of the National Labor Relations Board virtually insures a new philosophy of that major trouble spot. Several of the more radical staff members resigned when it was known that the President was going to name Millis as a successor to Madden, offering convincing proof of the more judicial character of the proceedings to be expected in the future. Millis is one of the most experienced labor conciliation men of the country and brings a spirit of cooperation in labor settlements to his new post. However, neither Millis nor Leiserson have any sympathy for a breakdown in the 40-hour week program. However judicial they may be in labor disputes, they will probably offer little if any encouragement for a longer work week.

More Zinc Promised—Domestic producers of zinc have privately assured the government that they will increase the United States smelting facilities so that there will be no zinc shortage in the defense program. The only subsidy they ask is an assurance that the five-year amortization plan will apply to the new capital investment. Domestic ore supplies are not expected to be quite adequate to care for full operation of enlarged plant facilities. But imported ore is readily available in this hemisphere. And the buying of such ore for the defense program is a welcome move in diplomatic channels, part of the effort to stabilize the economy of our Latin neighbors.

Loans for Defense—Uncle Sam would like private bankers to do as much of the loaning of money for new defense undertakings as can possibly be arranged. This conserves Treasury funds and the loaning power of RFC. But if bankers can't do the job the government will. Jesse H. Jones is the authority for this. And he promises that the loans will be at interest rates ranging from 1.5 to 4 per cent, according to the risk involved in the credit. Where the loans are to be reimbursed under definite agreements between contractors and the War or Navy Department, the lowest interest rate will prevail. This is just good banking practice, Mr. Jones says; but commercial bankers still worry about the low interest rates offered by RFC.

Copper Specialist—The Defense Commission has named as a member of the Stettinius division of raw materials John A. Church, consulting mining engineer, New York, formerly of the Ducktown Chemical & Iron Company, to serve as zinc and copper specialist in the minerals division. Mr. Church began his work in the Advisory Commission staff during November.

Silicosis Report—Until lately the details of the proceedings at the great Silicosis Conference held at Geneva, Switzerland, in 1938 have not been generally available in the United States. Now those proceedings are being distributed by the Washington branch of International Labor Office, 734 Jackson Place, Washington, D. C. This volume ($1.25 per paper bound copy) gives in full the proceedings of the international conference held Aug. 29 to Sept. 9, 1938. The volume also includes fourteen technical appendixes summarizing the reports of specialists of international reputation with respect to biochemical, pathological, and industrial problems involved.

Delays at RFC—Early in October the Defense Commission turned over to RFC the job of negotiating contracts for new synthetic rubber supply. At that time there were definite plans under which it was hoped that arrangements could be made to assure United States capacity for this chemical operation equal to at least 100,000 tons of synthetic rubber per year by the end of 1941. Even as late as Thanksgiving there had been no action at RFC settling these important contracts. This is leading to serious criticism of that agency elsewhere in Washington. The mining industry will be deeply concerned if a similar situation develops with reference to tin smelter contracts. Such difficulty is apparently anticipated, at least by some of the pessimist observers.

Congress Did Not Quit—When Congress resumed meetings after the election, the House decided that it would not immediately adjourn until January. The combination of conservative Democrats with Republicans was sufficient to keep both Houses nominally in session. The purpose was to apply Congressional brakes on the trend toward war activity, not primarily to enact legislation.

Domestic Manganese Contracts—About a half dozen American firms have been given an opportunity to prove whether they can produce an acceptable grade of manganese ore at the price which they estimate in their claims to the government. Uncle Sam has plenty of funds available to buy any actual output achieved. If these firms find that they cannot go ahead and begin deliveries within about six months, their contracts may be cancelled and the deal is off. No one is hurt by this arrangement; and one or two of these domestic firms may actually deliver on their contracts. But Uncle Sam is not counting on these for the backbone of any military supply of manganese.

What Are "Hours Worked"?—The Wage-Hour Division of the Department of Labor can be expected to compute working time under its law on the same basis as exists in the contracts between the employer and miner in any particular locality. If the worker gets paid from the time he reaches the mine until he leaves the property, then within the meaning of the law those are "hours worked." If the pay is on the basis of "face to face," then those hours will govern in determining when overtime begins, with its extra pay. Administrator Fleming definitely seeks to avoid changing these customary contractual relationships as he administers the Fair Labor Standards Act. Fact-finding conferences on these questions were scheduled to be held during December at both Salt Lake City, Utah, and at Birmingham, Ala.

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Developments and trends throughout metal consuming markets add immediate new importance to the production pace now needed across E.&M.J.'s entire field. Enlarged world-wide consumption and vast stores of all metals are required for National Defense Plans as well as for overseas war needs.

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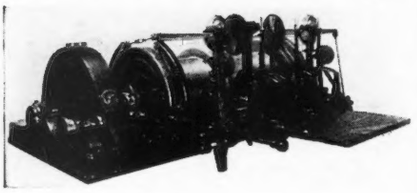

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These hoists are equipped with the latest type of Control and Safety Devices.

Every hoisting problem has a correct solution. Ottumwa has the experience to work out the right solution for your hoisting needs. Call on us.

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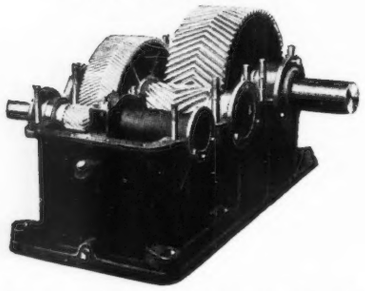

Ottumwa Reduction Units and Speed Increasers equipped with Ottumwa-Sykes continuous tooth herringbone gears are available in all sizes and ratios. These units are rugged in design and are admirably adapted for mill and mine service.

The increased bearing surface and greater load carrying capacity of herringbone gears gives a greater factor of safety and longer life. Their accuracy makes them the most efficient gears known to-day.

In addition to gear units we are prepared to furnish gears in all pitches from 16 D. P., to 1¼ D. P., and all sizes up to 122" diameter, 24" face.

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NEVADA

Copper Canyon Property Being Drilled

International Smelting & Refining Company is conducting investigation of gold-silver-copper deposit — Greenan Placers, Inc., has obtained approval for R.F.C. mining loan

▶ Three diamond drills, operating on a two-shift basis at separate points, are employed by the International Smelting & Refining Company in prospecting at depth the gold-copper zone on property of the Copper Canyon Mining Company in Lander County. International has an option, extending six months from Sept. 9, on 2,000,000 shares of Copper Canyon stock at 25c. per share, and if the option is exercised it will develop and equip both the Copper Canyon and Copper Basin properties, constructing a large-capacity mill at the former. The properties are 9 miles apart, southwest of Battle Mountain. At Copper Basin the reserve is estimated at 1,000,000 tons of plus 2 per cent copper ore above 400-ft. depth and at Copper Canyon 600,000 tons of gold-silver-copper ore of $9 to $10 value above a vertical depth of 297 ft., with additional developed ore to the north not included. Production of shipping ore has approximated $3,400,000 in smelter returns. Arthur A. Aaron, president, and Louis E. Whicher, treasurer, have offices at 25 Broad St., New York City. Robert H. Raring is resident engineer and manager, receiving mail at Battle Mountain.

▶ Subject to examination and checking of test results, the Reconstruction Finance Corporation has approved a Class A loan of $1,050,000 to the Greenan Placers, Inc., owning around 5,000 acres covering broad alluvial fans below the outlet of Copper Canyon, 16 miles southwest of Battle Mountain in Lander County. Test work already accomplished was said to have proved, by close drilling, approximately 24,000,000 cu.yd. of 22c. gravel and 32,000,000 yd. of 14c. gravel. The enterprise is headed and owned by James O. Greenan, First National Bank Building, Reno.

▶ Directors of the Mountain City Copper Company, operating the Rio Tinto mine and 350-ton flotation mill 68 miles north of the rail point at Elko, have declared a dividend of 25c. per share, payable Dec. 20. Dividends aggregating 61c. were paid in 1936, 1937, and 1939. International Smelting & Refining Company, subsidiary of Anaconda Copper Mining Company, owns 61 per cent of the 2,371,427 issued shares of 5c. par value. J. O. Elton, Kearns Building, Salt Lake City, is president and J. J. Lillie is manager at Rio Tinto, Nev.

▶ A gold-silver prospect discovered two months ago at an isolated point in the desert in western Pershing County by J. C. Stagg, prospector who discovered the widely publicized Jumbo gold mine, at Awakening, is attracting wide interest. An option was taken from Stagg for a small San Francisco partnership group. J. B. Stott, at Lovelock, Nev., in charge of the property for the Twin Buttes Mining Syndicate, organized by the California group, reports development in progress through two tunnels and a shaft down 35 ft. in high-grade ore, a 6-ft. width sampling $65 per ton.

▶ With the purpose of determining means to remove exceedingly hot water from a part of the ore-channel below the 100-ft. level, wells are being drilled on the Dixie Valley gold-silver mine of the Comstock Keystone Mining Company, in Churchill County, control of which was purchased recently by George Wingfield for the Goldfield Consolidated Mines Company. Good ore was opened above a depth of 73 ft. and in two winzes, but hot water halted work below that level. A pilot mill treated 8,000 tons, with recovery of over $145,000 and the tailing sampling $7.20 per ton. It is now the purpose to provide a modern cyanide plant. Offices are in San Francisco.

▶ Application has been made by the Buffalo Valley Mines Company, with gold-silver property south of Valmy, in Lander County, for a second Class B loan from the RFC of $20,000 for the further development and blocking of orebodies. John T. Reid, mining engineer and veteran operator of Lovelock, is president.

▶ In the past three months Greenan Quicksilver, Inc., has produced 727 flasks of mercury from its furnace on the Blue Can cinnabar mine, in the Bottle Creek district, Humboldt County.

▶ Extensive test work is being conducted by the Natomas Company of California on placer deposits at Round Mountain, 60 miles north of Tonopah, in Nye County. Natomas holds an interest in and directs work of the Manhattan Gold Dredging Company, operating an 18,000-cu.yd. bucket-line dredge in the flat below Manhattan, 10 miles south of Round Mountain.

▶ The Western Alloys, Inc., of Salt Lake City, Utah, put its new 300-ton concentration plant near Valmy in operation on Nov. 1. A power-shovel is being used to load the ore at the company's manganese deposits, according to a report by J. F. Featherstone, vice-president and general manager, Felt Building, Salt Lake City.

COLORADO

Lead-Zinc Property Reopened at Rico

St. Louis Smelting & Refining Company will resume production from its developed mine—New monthly advance record made at Carlton tunnel

▶ The local offices of the St. Louis Smelting & Refining Company at Rico have received orders from the main office for the reopening of its lead-zinc property. About one hundred men will be employed.

▶ The new Carlton drainage tunnel, in the Cripple Creek district, drove 1,787 ft. in October—a new record for one calendar month. This is an average of 57.7 ft. per twenty-four hours.

▶ Walter A. Moore, president of the Great Western Mines Corporation, recently closed negotiations for the W. E. Dewey mill, near Ward, and is moving all the equipment to the Blue Bird mine, near Nederland. The rich 2-in. streak of silver ore has increased to about 18 in., according to Mr. Moore, and also carries some ruby silver. The high-grade ore will be shipped direct to the smelter, and thirty thousand tons of mill ore will be treated in a new plant to be erected near the tunnel.

▶ Idarado Mining Company, centralized at the Treasury tunnel, near old Red Mountain, between Ouray and Silverton, recently installed a large compressor. Extensive development work is under way. R. J. Hendricks is manager, and Oscar Johnson and G. S. Hinsdale form the directorate of Idarado.

▶ New Jersey Zinc Company, owner of the famous Eagle mine, at Gilman, is shipping large quantities of iron-copper-silver-gold-lead ore to Utah smelters. In the late twenties, the New Jersey Zinc Company built a 600-ton zinc-lead flotation mill, underground, because of the hard winters in this locality for milling operations. After operating this underground zinc-lead mill in 1930 and 1931, zinc dropped to a low price and the company drove a tunnel from the mill level, to reduce the costs of transportation of ore. It was during this operation that the large body of copper-silver-gold ore was found and developed.

▶ Through persistent efforts of Joseph M. Bradley, president and general manager of the Highland Mary Gold Mines, the faulted portion of Highland Mary gold vein is reported found in a crosscut recently completed. The mine is in Cunningham Gulch, Animas district, San Juan County, near Howardsville.

▶ The Rico-Argentine Mines, operated by Salt Lake City interests at Rico, reports a net profit of $33,837.56 for the third quarter before depreciation and Federal taxes. Ore sales for the nine-month period amounted to $278,520.95. Samuel S. Arentz, Jr. is the company engineer.

UTAH

Manganese Investigations May Be Expanded

Installation of facilities at Bureau of Mines Station for broader scope of study awaits Washington approval—Elton tunnel passes through Occidental fault

▶ Construction of additional facilities at the United States Bureau of Mines building on the University of Utah campus, Salt Lake City, at a cost of $70,000, is awaiting approval of Washington, D. C., officials, according to an announcement by Dr. R. S. Dean, chief engineer of the metallurgical division. The new space will be used to house $100,000 of equipment for investigation of the West's manganese ore resources. A study of deposits in southern Tooele County and Juab County, and of those in western Nevada, is being made.

▶ The Elton Tunnel of the National

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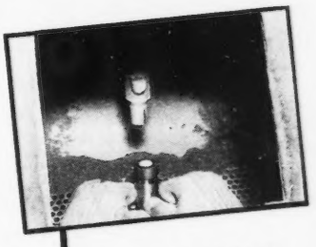

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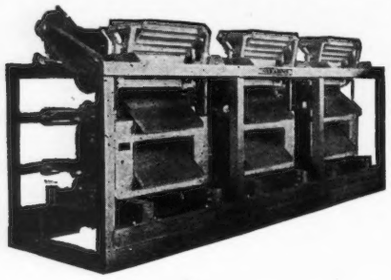

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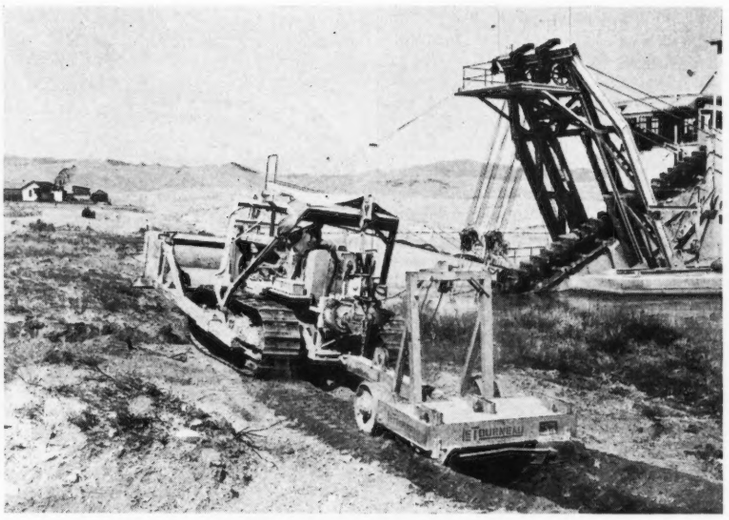

At the Last Chance Gulch near Helena, Montana, this bucket type gold dredge of the Porter Bros. has completed another successful season. In the foreground is a Caterpillar diesel tractor pulling a LeTourneau rooter that loosens hard packed or frozen ground for stripping operations. Loose material is then removed by the bulldozer attached to the front of the tractor.

▶ UTAH

Tunnel & Mines Company, operating near Tooele, has passed through the Occidental fault and entered a solid quartzite formation near the 19,500-ft. mark. The broken formation reduced progress to 286 ft. last month. Water flow is 3,587 g.p.m.

▶ The Tintic Diamond Mining Company plans to run a drift from the South Buckeye Shaft in the Diamond district, 5 miles south of Eureka.

▶ The New Park Mining Company made $144,813 net income during the first nine months of 1940, excluding depletion and Federal income tax, reports W. H. H. Cranmer, manager of the East Park City district property. Debts amounting to $285,000 have been paid and new equipment has been installed. The connection between the main Mayflower tunnel and Park Galena workings above has been made. A crosscut has been started 100 ft. above the tunnel level to prospect an unexploited fissure, known as the Pearl, says Mr. Cranmer.

▶ Stockholders of Kennecott Copper Corporation at a meeting on Nov. 6 approved and adopted a retirement plan of the company and its wholly owned subsidiaries operating in the United States for employees over 35 years of age who have completed accreditably a year of service and are receiving a salary at the rate of more than $3,000 a year. A director will not be eligible unless he qualifies in a capacity other than as director. The plan became effective as of Nov. 1 1940. The following is the retirement policy applied to all eligible employees: until January 1, 1946, the normal retirement age of male employees shall be 70; during the year 1946, 69; during the year 1949, 66; and thereafter the normal retirement age shall be 65. The normal retirement age for female employees shall be 60.

MONTANA

Large Dredge Ordered For Emigrant Placer

Operations of a 10-cu.ft. bucket-type gold-recovery unit expected to begin next summer in a promising area

▶ Lucky Tiger-Combination Gold Mining Company, 710 Commerce Building, Kansas City, Mo., recently announced it had signed a contract with the Yuba Manufacturing Company for the construction of a 10 cu.ft., bucket-type gold dredge for the exploitation of the company's recently tested placer area at Emigrant. A contract has also been let for the construction of a power line from Livingston to Emigrant. Based on reports of company engineers, it is estimated the placer contains eighteen to twenty million yards averaging 27.6c. per cubic yard, from the top of the deposit to a depth of 90 ft. Thomas W. Thompson is general manager at the placer. L. R. Budrow is consulting engineer for the company and A. E. Mosier is president.

▶ Directors of Anaconda Copper Mining Company have declared a dividend of 75c. per share on the outstanding capital stock, payable Dec. 23 to stockholders of record Dec. 10, 1940.

▶ A 4 per cent dividend was paid on Nov. 1 to stockholders of the Mapleton Gold Mines, Inc., a Utah corporation with offices in the McIntyre Building, Salt Lake City. W. J. Franklin is president. The property, situated in the Virginia City, Montana, district, is shipping three carloads a week of gold-silver ore.

WASHINGTON

Base-Metal Output Gradually Increasing

Mines in Metaline district will contribute major part of Washington's 1940 zinc production—Grandview mill operating on three-shift basis

▶ American Zinc, Lead & Smelting Company is operating its Grandview mill on a three-shift basis treating 450 tons of zinc-lead ore per day. About half of this production comes from the Grandview mine and the remainder from the property of Metaline Mining & Leasing Company. Both these properties are under the management of D. I. Hayes, of Spokane, engineer of the American Zinc Company. The property of the Grandview company is being steadily developed and is now said to have three years' ore supply. Development also continues at the property of Metaline Mining & Leasing Company. These two enterprises, together with that of Pend Oreille Mines & Metals Company, are the producers in the Metaline district, in the northeast corner of the State. The production is chiefly zinc, with a substantial amount of lead, and output of both metals is gradually increasing throughout the State.

▶ Consolidated Mines & Smelting Company of Washington has constructed a two-story bunkhouse and other buildings at a cost of about $10,000 at its property near Kellar. The company has an extensive holding containing gold, silver, copper, lead, and molybdenite.

▶ Leasers of the old Electric Point mine, in northern Stevens County, are said to have opened ore in the chimney, recently discovered, which is as rich as any found in the property during the last 25 years. Some of the galena ore, in large boulders, is almost a pure lead sulphide.

▶ Industrial Tungsten Corporation, of Spokane, is producing a good grade of wolframite concentrate at its new 35-ton mill 50 miles northwest of Spokane. J. E. McCloskey, managing director, says the concentrate is running about $2,000 to the ton. R. B. Greene is president. This property is near the well-known Germania, which in the past had a heavy production record of tungsten ore, and it also adjoins the tungsten property of James Keith, of Spokane.

▶ The University of Washington College of Mines will hold its seventeenth annual Mining Institute at the Mines Building on the campus Jan. 20 to 25, Milnor Robert, dean of the College of Mines, recently announced. Mining men and metallurgists from throughout the Pacific Northwest and Alaska are expected to attend the convention. The latest advances in mining methods, metallurgy and ceramics will high-light topics to be studied at the institute, which will include several field trips.

▶ Carl Lundstrum, of Electric City, Wash., who has acquired the Arlington mine, in the old Ruby district of Okanogan County, is hauling Arlington ore to the 50-ton custom plant he recently built near Nighthawk.

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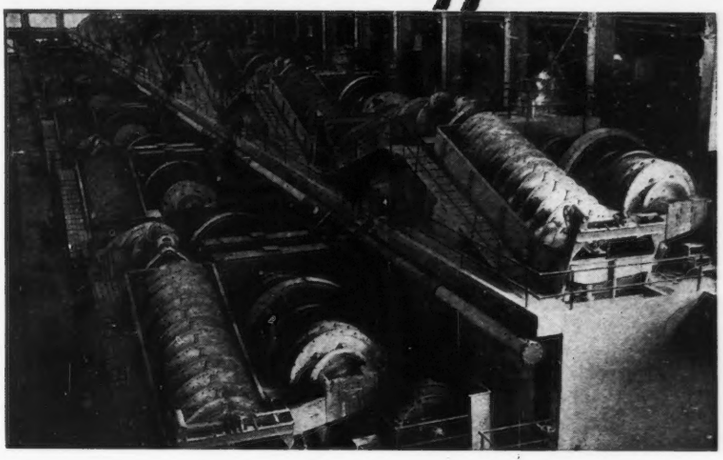

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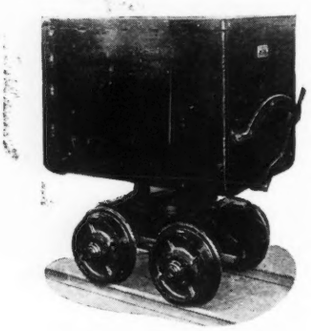

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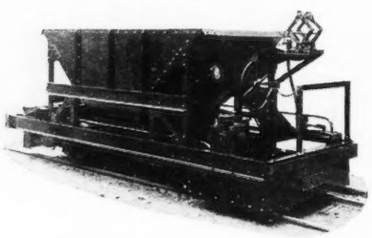

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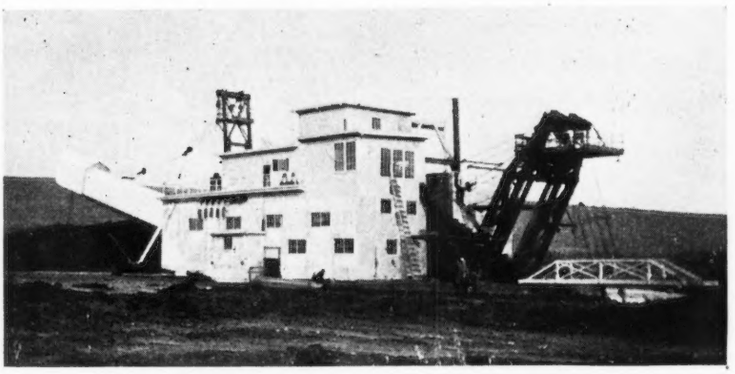

The latest addition to Alaska's list of gold dredges is this Yuba 6-cu.ft., bucket-type, diesel engine operated dredge of Livengood Placers, Inc. Operations started near Livengood on Sept. 5, several months ahead of schedule.

OREGON

Tramway at Simmons Mine Destroyed by Fire

Replacement expected to be made in the Spring—Aurum Mines Company plans to install concentrating plant

▶ The new tramway built to convey ore from the Simmons mine, in Baker County, to a terminal three miles below, was destroyed by fire on Oct. 30, with damage estimated at $20,000 and no insurance. Men coming off shift at 3 o'clock were being lowered on the tram when the fire was discovered. The control man handling the brakes first discovered the danger and might have put out the blaze but refused to leave his post until the men on the tram were safely landed. Leverett Davis, who is operating the mine, says it is so high on the mountain he will not attempt to repair the damage until spring.

▶ Aurum Mines Company is developing its property, the Rabbit gold-silver mine, at Whitney, and has reached a depth of 160 ft. The company expects to go into production, and perhaps install a mill and mining equipment, in the spring. James Bennet, of Whitney, is president and manager and Paul C. King, of Portland, is secretary.

▶ Ralph Davis, Inc., of Marysville, Mont., has leased the North Fork Placers on the John Day River, in Grant County. The officials of the Morrison-Knudson Company, of Boise, Idaho, and other Boise men are interested in the enterprise. A 4½-cu.yd. dragline and washing plant will be installed and it is expected the property will go into operation this winter.

▶ Oroplata Mining Company has a dragline dredge in operation on the Grande Ronde River, 46 miles from LaGrande. It handles 3,000 cu.yd. a day. This company operated three years in Grant County before moving to this location. S. K. Atkinson, Sr., of Boise, Idaho, heads the enterprise. The company was confronted with the problem of collecting fine gold in large quantities of sand found in the gravels. It has overcome this difficulty by putting amalgam plates along the trommel where much of the fine gold occurs.

▶ Oregon Quicksilver Company is producing eight to ten flasks of mercury a month, with fifteen men employed, under George S. Barton, of Eugene, manager. Additional equipment is planned for the spring, which will increase development.

▶ Southern Oregon Mining Company has moved its dry land washing plant from the Lance placer ground, in Jackson County, to the Hamilton and Taylor ranches on Applegate River. The plant consists of a 1-cu.yd. shovel and a dry-bank washer, capable of handling 80 cu.yd. per hour. J. B. Bowdish, of Medford, is superintendent.

ALASKA

Several New Gold Dredges Add to 1940 Output

New developments also made in lode mines—Livengood Placers closes season with good results reported

▶ Dr. Phillip S. Smith, chief United States geologist for Alaska, reports that Seward Peninsula Placer Gold operations will return as much in 1940 as they did last year or perhaps more. Rains were heavy and helpful. Several new dragline, dredge, and other placer operations were started this year in that region.

▶ Livengood Placers, Inc., started operations with its first dredge on Sept. 6, 1940. Operations continued until Oct. 15, 1940, when the dredge was shut down for the winter. In its first run the dredge handled satisfactorily about 125,000 cu.yd. of gravel and recovered about 70c. per cubic yard—somewhat in excess of drilling estimates. Final work on the tunnel and ditch lines during the winter months is expected to complete these parts of the water supply system for use early in the 1941 season. Work at the dam during 1940 progressed sufficiently to insure its completion on schedule before the end of the 1941

season. Resumption of the dredging operations will take place as soon as weather permits in the spring, probably about May 1. Funds available under the RFC loan, together with amounts already advanced, will be sufficient to complete the project. In view of recoveries during the first run of the dredge, it seems probable that completion of the dam can be accomplished without drawing down the full amount of the authorized loan. Charles Lewis is in charge of operations at Livengood.

▶A new 20-ton ball mill has increased production to 65 tons daily at the Lucky Shot mine, in the Willow Creek district, according to A. W. Freakes, manager. Mr. Freakes says permanent production has been assured by reopening the vein beyond the fault. A new adit has been driven 1,400 ft. to provide extra haulage facilities. Sixty-five men are employed.

▶Fred Crane is opening an old cinnabar property now held by leasers two and a half miles from Livengood, 81 miles from Fairbanks. The owners, years ago, took out what quicksilver they needed for their gold placer operations. Mr. Crane cleaned out the old tunnel, extended it 165 ft., and made tests during the season to determine the nature of a mill needed.

▶John and George Miscovich have acquired the Billy Bick ground near Poorman and will use tractors, bulldozers, and hydraulic equipment to exploit the property in the spring. The pay channel is 800 to 1,200 ft. wide, covered with about 40 ft. of overburden.

IRON COUNTRY

Busy Shipping Season Comes to a Close

Total shipments of iron ore for 1940 reach 63,709,152 tons, the highest in 11 years—Large stripping programs get under way

▶Consumption of iron ore during October was 6,051,347 tons and almost equals the record consumption of May, 1923, which amounted to 6,118,540. The furnaces using Lake Superior iron ore consumed 50,280,269 tons during 1940 up to Nov. 1. A balance of 41,125,450 tons is shown as on hand at the Lake front docks and furnace yards. Since the shipments from the Upper Lake docks during November amounted to 5,412,798 tons, the consumption may exceed the shipments. This means that if during the next six months the furnaces consume iron ore at the rate of 6,000,000 tons a month, a balance of between 10,000,000 and 11,000,000 tons will be on hand May 1, 1941. This is a very low balance and means that early shipments can be expected to Lake Erie docks.

▶Oliver Iron Mining Company is shipping until the first part of December and has been working at capacity at all Minnesota mines, especially in the Hibbing-Chisholm district.

▶Canisteo Mining Company is undertaking a large stripping operation at the Canisteo mine, at Coleraine, Minn., 24 hours a day and six days per week and will continue most of the winter.

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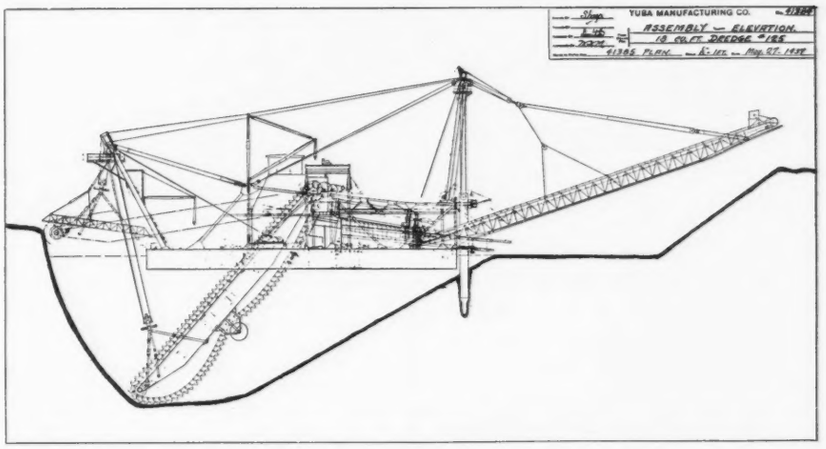

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▶IRON COUNTRY

▶ The Hill-Annex mine, at Calumet, Minn., of the Inter-State Iron Company, has a large stripping program which will require work late into the winter months to complete.

▶ The Pickands, Mather & Company are busily engaged in work at the old Dunwoody mine, at Chisholm, Minn., and this mine will be in more active production during the 1941 season.

▶ Butler Brothers are working on a stripping job at the Galbraith Mine, at Nashwauk, Minn., and expect this mine to be in production during the 1941 season.

▶ Most of the independent mining companies have completed their shipping schedules and are now engaged in winter repair work and other stripping or clean-up jobs; and all operators are getting the mines in condition for a record production during the 1941 season.

▶ The Republic Steel Corporation will reopen the Tobin mine, at Crystal Falls, Mich., and place this mine in production as soon as possible.

MICHIGAN

Quincy Copper Mine Improves Ore Position

Development on four deep levels reveals additional ore of good grade—Michigan organizations protest against freezing copper price at 12c.

▶ For many years the basic lode in the Quincy mine, running through the property, has been the Old Pewabic. It was low in mineral content, however, compared with other lodes of the Pewabic series. Recently it was found that north of No. 8 shaft the copper content of the ore increased in this basic vein, and the results have been most encouraging. Apparently this change in mineralization has added many years to the life of the mine, whose history extends back over 90 years. Three long crosscuts have been driven into the lode, and stoping and drifting are proceeding on the 77th, 78th, 79th, and 81st levels. There also are possibilities that equally good values will be found above the 77th and below the 81st. Quincy's yield of copper per ton of rock mined is now in excess of 30 lb.

▶ Agreement recently was reached between the Isle Royale Copper Company and Local No. 513, International Union of Mine, Mill and Smelter Workers (CIO), when a contract proposed by the company was ratified by union members. The agreement will run until Aug. 1, 1941. Included in the contract is a wage adjustment, as well as seniority rights, the check-off, and arbitration procedure. The contract calls for a change of 10c. in the daily wage each time the price of copper advances or drops one-half cent, except that if the price of copper should be between 12c. and 12.49c., the raise would be 20c. per day. The basic daily pay for miners, company account, when the price of copper is under 9c. a pound, will be $3.10. Present basic pay is $3.70 per day, plus bonus for drilling.

▶ Chambers of commerce and other organizations in the Michigan copper district have passed resolutions protesting against the freezing of the price of copper at 12c. per pound. The resolutions ask that the price of copper be maintained high enough to keep workmen off relief, declaring that the price must be high enough for the small mines and high-cost producers to operate. Many mines in this district have been closed during the past ten years because of the low price of the metal. The resolutions have been forwarded to Michigan's Senators and Representatives; also to Leon Henderson, chairman of the price division of the National Advisory Defense commission.

TRI-STATE

More Old Zinc Mines Reopen

Three mills rehabilitated for production in December—Higher zinc price permits exploitation of some lower-grade orebodies

▶ Although the advent of a $48-a-ton market for zinc concentrates in the Tri-State district of Oklahoma, Kansas, and Missouri has stimulated some new production, it has failed to increase the weekly total output of the mining field. This is due to the fact that many of the companies operating in the area have taken advantage of the price to mine lower-grade ore reserves. Weekly production at the $48 price has been averaging slightly less than 9,000 tons, with practically all the available plant capacity in operation. Three additional plants are scheduled to get under way during December, and possibly may increase the weekly production to around 9,250 tons. These plants are the new Eagle-Picher mill near Wentworth, the new mill of the Rialto Mining Corporation at Cardin, and the old Grasselli plant at Thoms Station, which has been reconditioned by the St. Louis Mining & Milling Corporation. It is apparent that a further increase of from $5 to $10 a ton in the price will be required to bring out an additional 500 to 1,000 tons in the weekly production.

▶ New mining activity of the past month has witnessed the reopening of a shaft on the Wild Bull lease, the farthest westerly development in the entire Picher field, by the Roan Bull Mining Company, Inc. Operations are on the 170-ft. level, above the water table of the area, and preliminary tests of the ore is being made over the Eagle-Picher Central mill. Officers of the company are Henry W. Robertson, of Joplin, president; Carl Williams, vice-president; and P. T. McLaughlin, of Miami, secretary-treasurer.

▶ Floyd Craig and associates have reopened the old Hobart mill shaft, three-quarters of a mile north of Quapaw, Okla. Ore is being treated over the Mission Mining & Royalty Company mill on the adjoining lease.

▶ The No. 4 mines and mill of the Evans-Wallower Zinc, Inc., southwest of Picher, have resumed operations after a three-month shutdown, according to Floyd Gooch, of Joplin, company manager. Approximately 50 men were reemployed.

▶ Cameron & Henderson, Inc., have purchased the stock of the Tongaha Mining Company, including the 200-acre Foch mining tract and equipment. The Foch property is situated a mile and a half west of Picher. The corporation also has leased from Eagle-Picher the Kitty 80-acre lease, which adjoins the Foch on the west and south. Mining operations are being carried on under the name of the Tongaha Mining Company. About 30 men are employed. Officers of the Tongaha company are L. F. Scofield, of Picher, president; Morton Z. Douthat, of Joplin, vice-president; and S. E. Henderson, of Baxter Springs, secretary-treasurer. Cameron & Henderson plan later to make an underground clean-up of the old Kitty workings.

▶ The Bilharz Mining Company has reopened the No. 6 shaft on the Brewster lease, a mile northwest of Baxter Springs, which is being sunk from the 154- to 180-ft. level following the dewatering of the area under the supervision of O. W. Bilharz, of Baxter Springs.

▶ Northside Mining Company is sinking a new shaft on the Cole land, a 160-acre tract situated a mile northwest of Chitwood, with C. M. Weston, of Kansas City, in charge. It will be put down to a depth of 185 ft., and will be 6x7½ ft. in the clear.

▶ Kansas Explorations, Inc., is doing some churn drilling on the Snapp land, northwest of Oronogo, according to Ross Blake, of Joplin, district manager of the company.

▶ The Youngman Milling Company has resumed operations at its tailing plant, north of Picher, in Kansas, according to H. D. Youngman, of Baxter Springs, company president. Tailings from the Wade custom mill, 5 miles to the east on the Kansas-Oklahoma State line, are being treated. The plant had been idle several months.

MEXICO

Some Companies Seek To Suspend Work

Unprofitable operations due to curtailed markets is chief reason given to Federal Labor Authority—Small miners also affected by lack of market for metals

▶ Cia. Minera de Peñoles has petitioned the Federal labor authorities for permission to suspend operations at its Aquiles Serdan unit, in Chihuahua, contending that curtailed metal markets is making work unprofitable. Cia. Minera Pinos Altos, at Pinos Altos, Chihuahua, has also sought permission to suspend operations for the same reason.

▶ Mining in Mexico felt a deal better as a result of Washington's official recognition of President General Manuel Avila Camacho in the form of President Roosevelt appointing Vice-President Wal-

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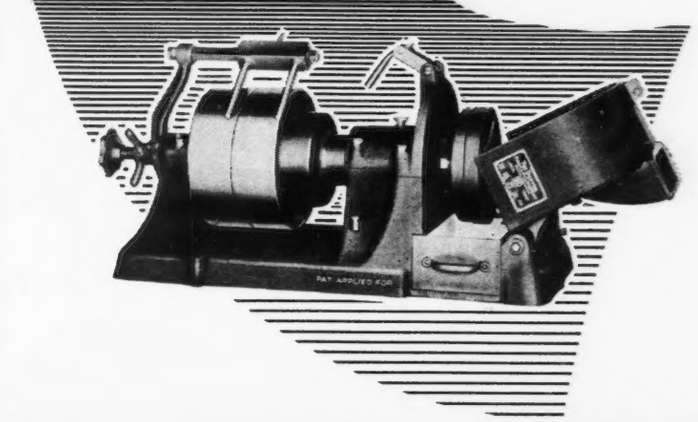

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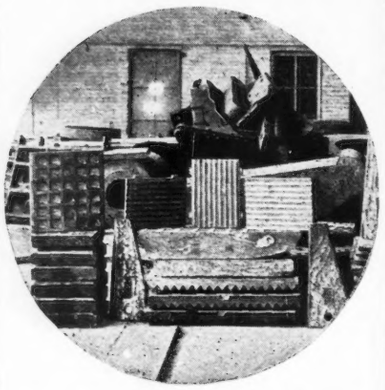

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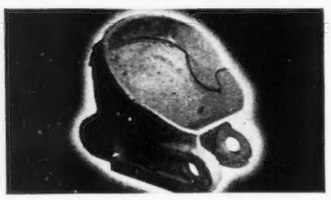

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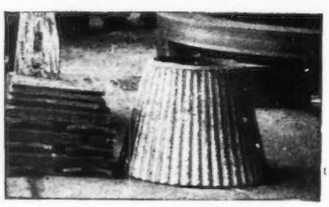

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▶MEXICO

lace to be his personal representative at the inauguration of the new chief executive on Dec. 1. Mining sees that action as clarifying the much-beclouded Mexican political situation, which should permit of a steady settling down to steady business with the turn of 1941.

▶No hope of settlement of the strike that began Oct. 10 against Mexican Zinc and Cia. Carbonifera de Sabinas, S.A., Nueva Rosita, Coahuila, both units of the American Smelting & Refining Company, is seen until after the new federal government gets down to business. Some chance of the ending of this strike is hoped for in December. Meanwhile, the Monterrey Iron & Steel Works, Monterrey, Nuevo Leon, Mexico's greatest enterprise of the kind, though deprived of Nueva Rosita coke, is able to get along with expensive imports of this fuel from the United States. The Nueva Rosita strikers are still defying the Federal Government, which has urged them to release coke shipment, saying that if they did that they would be defeating their own interests.

▶Cooperative and small-scale phases of Mexican mining are in such a bad way because the war is progressively reducing foreign demand for Mexican silver that unless the Federal Government financially assists these workers many of them will be unemployed. The national mining council thus expresses a warning in asking the Ministry of Finance to come to the aid of these workers.

▶The Federal Labor Department has ruled that mining companies must be included among the industrial enterprises that are obliged to maintain permanent representation before the federal board of conciliation and arbitration. The representation is intended to assure the most fair consideration of labor cases, the department explains.

▶Cia. Minera Real del Montey Pachuca, Pachuca, Hidalgo, lost some 2,500,000 pesos ($500,000) to ore thieves in eighteen months, according to the Mexican secret service. Several arrests, including that of a Ministry of Finance mines inspector, have been made in connection with these robberies. The secret service has increased its efforts to wipe out ore thieves, as many mining interests warned the government that this pilfering threatens to drive many small enterprises out of business.

▶A curious case regarding mining silicosis sufferers' indemnifications is before Mexican courts. The supreme court, holding that it has as yet no jurisdiction in such cases, turned back to the first district court, Mexico City, an appeal of Cia. Minera Santa Maria de la Paz, Villa de la Paz, San Luis Potosi, to upset the award of the Federal Board of Conciliation and arbitration favoring several of its miners who suffer from silicosis. The company said that it had made an indemnification agreement with these miners and had paid them compensation. But when the payment was made, the miners appealed to the board, which allowed them a second compensation. The company argues that this indemnification is unjustified.

▶The federal board of conciliation and arbitration has ordered Minas de Tajo, S.A., Rosario, Sinaloa, to pay heavy indemnifications for two cases of silicosis, 3,840 pesos ($768) for a death from this disease, and 1,750 pesos ($350) to a miner who is stricken with the ailment. The company was also ordered to improve working condition to reduce the hazard of this disease.

▶American Smelting has come to the aid of workers employed by the San Pedro and San Pablo mines, Nuevo Leon, who are to be dismissed because these properties' operators have advised the federal labor authorities that they cannot continue, as their pay ore has been exhausted. American Smelting has offered to give its Zaragoza mines, Nuevo Leon, to these workers to conduct cooperatively.

CANADA

Hollinger Ore Reserves Reach High Figure

Value of total gold output to date is placed at $300,000,000 — Senator-Rouyn Gold Mines starts producing — Central Zeballos mine, in British Columbia, reports high gold assays

▶ Hollinger Consolidated Gold Mines reports total production of $300,000,000 to Nov. 1, representing the first 30 years of the mine's operation. This figure comes close to being 50 per cent of the gold taken out of all mines in the Porcupine camp. The Hollinger is still a shallow mine, with about a third of the ore currently coming from above the 850 level, although orebodies have been developed below the 5,000-ft. horizon. Ore reserves have reached the highest point on record, valued at almost $100,000,000 with gold calculated at $35 an ounce. Dividends paid total $103,494,400. In the first six months of 1940 tax reserves amounted to $1,150,000, which is almost double the rate of a year ago. The annual payroll averages six million dollars for 3,024 employees.

▶ At the annual meeting of Teck-Hughes Gold Mines, the general manager, J. G. McMillan, stated that the discovery of branch veins three years ago had added more than 3,000 ft. of new vein and that ore from this source was now contributing about one-third of the gold output. Reserves have been well maintained and assure milling operations for at least two years at the present rate of 800 tons daily. In the 26 years of the mine's operation gold production has amounted to $72,480,000, of which 43.79 per cent has been paid out in dividends. Dr. D. L. H. Forbes, president, announced that it is proposed to produce as much gold as possible to provide Canada with needed foreign exchange.

▶ Shaft sinking to 2,500 ft. has been completed by Toburn Gold Mines, controlled by American Smelting & Refining Company. The property is located at the east end of the Kirkland Lake main break. For the past eight years, Toburn has been successful in mining old workings above 1,090 ft., as developed by the predecessor company, Tough-Oakes-Burnside. Cautious exploration is now proposed on the vein system at depth.

▶ Within its first full year of production, Chesterville Larder Lake Gold Mines has advanced mill capacity to 700 tons a day, operating costs have been cut below $3 a ton, and the first dividend has been declared. October gold production was at a new high, valued at $133,710; average recovery per ton was $6.11. Ore reserves are holding close to 900,000 tons. In addition to the four existing levels, a block of four new levels will be opened next year to explore the main ore zones below 550 ft. A new hoist, purchased from the Sylvanite, and a new headframe are expected to be in operation before the end of the year, when work will be started to deepen the main shaft below 1,000 ft.

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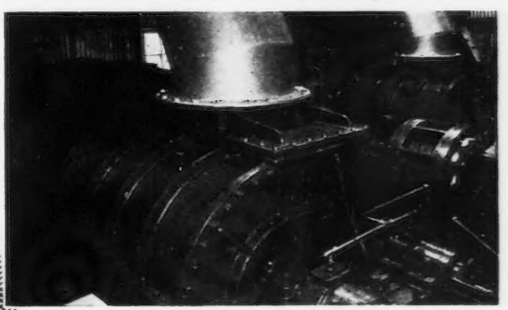

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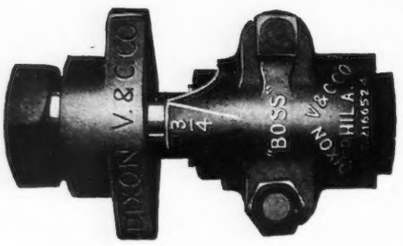

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▸CANADA

▸An important extension of ore reserves is anticipated at Upper Canada Mines before the end of December, with two new levels down to 1,000 ft. under development. Advance diamond drilling has proved the continuity of the three ore zones below the 500 level and some of the richest sections in the mine have been disclosed in the 625- and 750-ft. level drifts. After the first of the year a decision is to be made on mill expansion.

Quebec

▸Senator-Rouyn Gold Mines went into production on Oct. 15, using the leased mill of Arntfield Gold Mines. A 300-ton cyanide mill is under construction and scheduled to go into operation next May. By that time operating profits are estimated to total more than $200,000. The recent sale of notes netted the company $120,000 and an issue of $400,000 in first-mortgage bonds has been authorized, to be used as collateral for any bank loans that may be required to develop three new levels while the mill is being built. B. S. W. Buffam and Dr. W. F. James are consulting geologists.

▸W. B. Maxwell, general manager of Beattie Gold Mines, reports an important increase in production for the third quarter of 1940, $769,292, compared with $595,736 in the same period a year ago. Ore grade has been advanced from $4.09 to $4.88 a ton, with the mill treating close to 1,800 tons a day. Additional storage facilities for arsenic are under construction.

▸O'Brien Gold Mines reports an increase in ore reserves from 159,291 tons to 192,262 tons at the end of the fiscal year, Sept. 30. The president, J. A. O'Brien, showed that a decline in net earnings over last year was due to the mining of an ore grade more closely approaching the average for the mine. Plans have been made for a new internal shaft (No. 4) which will be started in January. Harry E. Sparks is mine manager.

▸New ore has been steadily accumulating in five parallel zones at Wood Cadillac Mines, a short distance east of the O'Brien. The exploratory drive on the bottom level has picked up new ore at a point 1,700 ft. east of the shaft.

British Columbia

▸Development work at the Central Zeballos mine, in the Zeballos district, is exposing ore bodies which show consistently high assay returns, according to a recent statement made by W. A. Sutton, secretary of the Reno Gold Mines, Ltd. Reno Gold Mines have spent over $100,000 bringing Central Zeballos into production. Of this amount, $60,000 was spent on development and mill and power plant construction in accordance with the terms of an agreement between the two com-

Professional Development Makes Progress in Canada

Engineering Institute of Canada becomes the eighth participating body of E.C.P.D.—Accredited curricula now number 540

AT THE 1940 ANNUAL MEETING of the Engineers' Council for Professional Development held on Oct. 24 in Pittsburgh, R. E. Doherty, president, Carnegie Institute of Technology, was elected chairman and Harry T. Woolson, executive engineer, the Chrysler Corporation, was elected vice-chairman. George T. Seabury, secretary of the American Society of Civil Engineers, becomes the E.C.P.D. secretary and H. H. Henline, secretary of the American Institute of Electrical Engineers, is assistant secretary. The other officers elected at the Pittsburgh meeting are A. A. Potter, chairman, Committee on Engineering Schools; Charles F. Scott, chairman, Committee on Professional Recognition; R. L. Sackett, chairman, Committee on Student Selection and Guidance; S. D. Kirkpatrick, chairman, Committee on Professional Training; and E. R. Needles, chairman, Ways and Means Committee.

By unanimous vote of the Council, the Engineering Institute of Canada became the eighth participating body of E.C.P.D. A delegation of members of the Institute, headed by J. B. Challies, past-president, was present. Dr. Challies, speaking on behalf of the president of the E.I.C., expressed the Institute's appreciation of the action by which it has become more closely affiliated with engineering bodies in the United States and announced the names of the Institute's representatives: J. M. R. Fairbairn, A. Surveyer, and J. B. Challies, all past-presidents of the Institute. Professor C. R. Young, University of Toronto, was appointed to the Committee on Professional Training. H. F. Bennett becomes a member of the Committee on Student Selection and Guidance, and James A. Vance will serve on the Committee on Professional Recognition.

For the Committee on Engineering Schools, whose principal function has been the accrediting of curricula, Dean Potter reported that as a result of the year's work and of actions taken on Oct. 24, 1940, the record now stands as follows: Total curricula submitted, including reinspections, 791; accredited unprovisionally, 457; accredited provisionally, 83; not accredited, 164; reinspections resulting in no change of status, 82; and those in which action is pending number 5.

panies. In consideration of this investment, Reno Gold Mines receive 40 per cent of Central Zeballos operating profits. The remainder of the investment represents money spent by the Reno company on additional necessary operations at Central Zeballos. The average width of the ore is from 7 to 8 in. Assay returns from samples taken across these widths show a gold content of more than 2 oz. per ton.

▶ At the Tagore mine, in the Zeballos district, now controlled by I. Rosenthal and associates of Seattle, it is reported that the crosscut has encountered the vein sought.

▶ D. S. Tait, president of Privateer Mine, Ltd., largest Zeballos district producer, states that the reduction in October production as compared with that of the previous month was entirely due to certain defective equipment in the mill. Tonnage capacity was materially reduced during the period. The defective mill equipment has been replaced and the mill is again operating with normal efficiency.

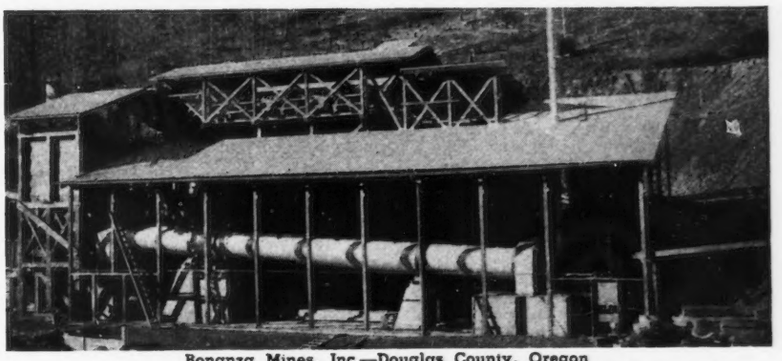
▶ Spud Valley Gold Mines, Ltd., second largest producer in the Zeballos area, has recently purchased an auxiliary power plant. The new equipment has been transported to the property and is being installed.

▶ The location and development of extensive additional ore bodies at Hedley Mascot Gold Mines, Ltd., is forecast in the report of Dr. V. Dolmage, consulting geologist, recently issued by the Hedley Mascot company with its quarterly statement. During the third quarter, under review, the company states that 17,191 dry tons of ore were milled. Net income after provision for all taxes, development, and exploration was $69,171.37. Earnings per share, before depreciation and depletion, were 3.05c.

▶ A. E. Jukes, president of Gold Belt Mining Company, in the Sheep Creek district of the Nelson mining division, states that an important new ore body has been exposed on the 1,425 level. The 1,435 drift has been extended for 178 ft., according to a recent report received from H. E. Doelle, mine manager, and ore exposed in this drifting has shown favorable assay results.

▶ Hedley Amalgamated Gold Mines, Ltd., will continue their policy of examination and exploration of prospects in an effort to secure a favorable property, according to W. G. Norrie-Loewenthal, managing director of the company. During the past year, thirty properties, including a number of oil ventures, were examined. One property in British Columbia showed considerable promise and appears to warrant further development.

▶ Edward Terzian, president of Gold-Silver-Tungsten Mining & Milling Company, operators of the Euphrates mine, in the Nelson mining division, recently announced that installation of an aerial tramway is proceeding. The building to house mill machinery has been completed and installation of milling facilities will soon be undertaken. Present plans are for a mill with a daily capacity of 100 tons, designed to permit expansion to a maximum treating capacity of 400 tons per day.



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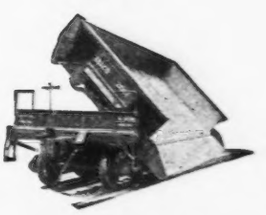

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AUSTRALIA

Concentrator to Be Erected at Ora Banda

Plant in Western Australia will treat low-grade gold ore—Mount Morgan reports substantial reduction in operating costs for year

▶ Ora Banda United Mines, Ltd., which has proved a large tonnage of low-grade gold ore on its leases at Ora Banda, is to erect a mill of 3,000 tons' capacity to treat oxidized gold ore. The size of the mill is stated to be limited by the available water supply, which, derived from the Goldfields scheme, cannot at present supply water for a greater tonnage. Ore is to be mined by open cutting; and a dragline is to be used. The equipment was purchased by J. Parker, Jr., general manager, during a recent visit to the United States. The ore is not expected to offer any metallurgical problems, and costs should be low.

▶ The New Milano mine, at Mount Monger, is to be shut down for about twelve weeks in order to carry out a shaft enlargement and development program to cost £A6,500. This campaign is considered justified by recent favorable developments at the mine. In the meantime, ore is to be supplied to the mill from the near-by Leslie lease, recently acquired by the company.

▶ Edna May (W.A.) Amalgamated Gold Mines, N. L., Westonia, has obtained mining reservations over two areas at the west and east ends of its leases, for protection during a diamond drilling campaign being carried out to prospect for possible ore occurrences beyond the present lease boundaries. The campaign has been laid out following on a geological survey of the ore deposits in the existing workings.

Victoria

▶ Central Nell Gwynne, Bendigo, treating 15,145 tons of ore during the half year to Sept. 30, recovered 6,006 oz. of gold, which, with pyritic concentrate valued at £1,164, produced total revenue of £A56,591. Net profit was £A37,961, working costs being 24s. 7d. per ton. The success of the Central Nell Gwynne has prompted the reopening of the South Nell Gwynne (formerly the Nell Gwynne (B.M.L.), worked by the Bendigo Mines group) and plans are also afoot for the floating of a company to take over an extensive area still further to the south.

▶ Owing to delays associated with the shortage of materials and engineering services, it is not expected that the new twenty-head mill being erected by Maude and Yellow Girl Gold Mining Company, Glen Wills, will be operating before the end of the year.

Tasmania

▶ Accounts of Aberfoyle Tin, N. L., Rossarden, for the year ended June 30, show a net profit of £A17,283 compared with £A14,053 for the preceding year. During the year, 16,327 tons of ore was treated, production being 293 tons of "first" concentrates and 510 tons of "seconds." Costs rose from 65s. 6d. per ton to 69s. 6d. Ore reserves show a rather marked drop at 49,106 tons, down some 12,500 tons on the year, but there are prospects of considerable ore in the lower sections of the mine which have not as yet been opened up to any great extent.

New South Wales

▶ Granites Development, N. L., which formed, and is now the sole owner of, Glen Innes Dredging, N. L., which has been working a property at Glen Elgin, in the New England district, with indifferent results, has decided to move the gold dredge to a lease at Araluen, on which test boring carried out some time ago showed that a profitable dredging area existed. The extent of the selected area is 2,000,000 cu.yd.

▶ Accounts of Broken Hill South, Ltd., Broken Hill, for the year ended June 30, show a net profit of £A329,503, or £A20,504 less than last year. The drop is more than attributable to provisions made for increased taxation and other contingencies. Production statistics have not been released this year, owing to the official restriction on the publication of such figures, but it is revealed that metallurgical results were the best in the history of the company.

Queensland

▶ Mount Morgan, Ltd., Mount Morgan, for the year to June 30 reports net profit of £A219,704, or more than double last year's figure of £A92,652. Contributory factors were increases in the prices of copper and gold and substantial reductions in costs, which compared with those of the preceding year as follows:

	1938/39			1939/40		
	Australian Currency					
Sulphide ore, per ton		s.	d.		s.	d.
Mining		10	4		7	2
Treatment		6	10		5	9
		17	2		12	11
Oxide ore, per ton						
Mining			10			5
Treatment		4	3		3	2
		5	1		3	7
Smelting, per ton copper	£31	6	0	£19	7	9

▶ Since the close of the financial year, the capacity of the smelting and converting plants has been increased to 500 tons of blister copper monthly, and the remaining section of the oxide mill has been converted into a sulphide mill, with the exception of the units employed in cyaniding the granular fraction of the sulphide mill tailings. It has been decided to resume the treatment of oxidized ores, however, and a plant for the purpose is in course of erection.

Yugoslavia—Correction

▶ Referring to a news item in our issue for last September, Anton Gray, managing director, Trepca Mines, Inc., cables that "not only has there been no confiscation of Trepca Mines properties, but the statement that 'Government commissioners are in charge' is completely untrue." *Engineering and Mining Journal* regrets publication of the statement, which originated in a usually reliable source.

EQUIPMENT NEWS

Polyphase Motor

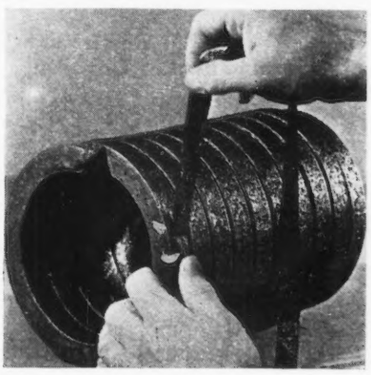
CONFORMING with new industrial trends, processes, and practices, the General Electric Company, Schenectady, N. Y., announces its complete new line of polyphase induction motors, in integral horsepower sizes, known as the Tri-Clad motor. It features streamlined appearance, more protection through the use of a cast-iron frame, advances in insulation by the use of the company's Formex magnet wire, and improved bearing design and lubricating arrangements, and it incorporates the cast-aluminum rotor.

The Formex wire used in this type of motor eliminates the use of paper, cotton coverings, and other fibrous materials which absorb moisture and deteriorate due to heat and chemical agents. The thermal capacity of the motor has been improved without reducing the space available for active materials. Efficiency of cooling is increased through smooth air passageways and baffles which control its direction, velocity, and discharge through openings in the frame. The motor is said to operate within the standard 40-deg. C. temperature rise. The improved-type sleeve bearings have a spiral type grooving that is said to maintain an oil film over all of the bearing linings, under any loading conditions.

A cast iron frame of the box type offers protection against rough usage of the motor and minimizes contact of vital motor parts against lubricants and other liquids.

Plastic Packing

CRANE PACKING COMPANY, 1800 Cuyler Ave., Chicago, Ill. announces a new development in the manufacture of its Super-Seal dry-graphitized plastic packing made from pure long-fiber as-



bestos, anti-frictional metal particles and special binders. It is made with a patented tape-back reinforcement securely vulcanized to the outer surface of the packing. This vulcanized reinforcement replaces the old frictional woven cotton jacket and now a non-frictional surface bears directly against the moving part. Due to the tape back reinforcement, this new packing is extremely pliable and can be bent around small-diameter rods and shafts without fracturing or cracking, or formed into small I.D. rings without distortion. Recommended by the manufacturer for services such as centrifugal feed pumps, low-pressure steam rods, valve stems, rotary pumps, and expansion joints.

Correction—In the description of the new Becker-Hopkins gold dredge by the Yuba Manufacturing Company, on page 91 of the November *E. & M. J.*, it was incorrectly stated that the dredge boom was actuated by compressed air. A wire rope winch arrangement operates the digging boom.

On page 92 of the same issue a misprint indicated the weight of the one-hour breathing apparatus of the Mine Safety Appliances Company to be 124 lb. The correct weight is 24 lb.

New Rail Punch

A NEW light-weight, portable rail punch of novel design is announced by the Gibraltar Equipment & Manufacturing Company, Madison at 14th St., St. Louis, Mo. The device, known as the

multiple leverage rail punch, features a system of links from the bar socket to the punch shaft said to reduce by two-thirds the power ordinarily required by conventional rail-punch units. Included in this arrangement is a new ratchet mechanism. The punch shaft is drilled at one end to accommodate the shank of the drill bit and a special thrust bearing made of "Gemloy" phosphor bronze to withstand the great pressures developed in punching holes up to 1 in. in steel up to 1 in. thick. A die corresponding in size to that of the punch bit in use is held in perfect alignment by means of a die seat accurately machined into the punch frame. The die is held in place by a slight press fit, and the punch bit is secured to the shaft by two removable steel pins.

Changing of the punch and die set is but a matter of minutes. These are available in sizes from ½ in. to 1 in. The punch frame is made from special heat-treated alloy steel, with a cast-on handle providing maximum portability. The new unit is designed especially for hard service.

An unusual type of magnetic separator which utilizes alternating current for energizing the magnetic field has been designed by the Stearns Magnetic Manufacturing Company, Milwaukee, and styled Type "AM." By this method of energization with alternating-current fields pulsating, the lines of force change 60 times a second, while the material affected by the magnet receives 120 pulsations of constant agitation. This separator is said to be particularly effective for treating finely ground powdered metal, which may be contaminated by any number of impurities such as oxide, scale, charcoal, silica, and other foreign particles

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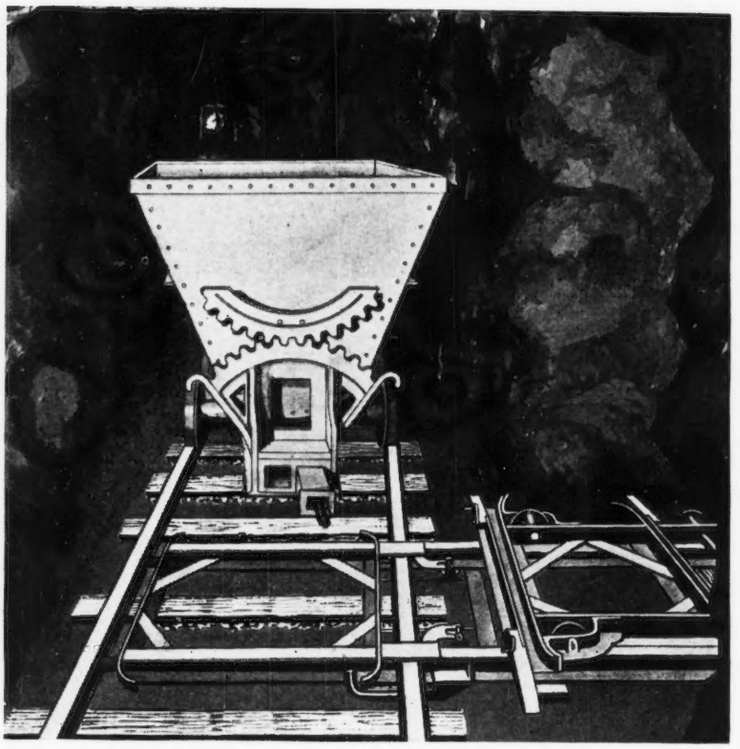
Mine-Car Transfer for Narrow Gage Track

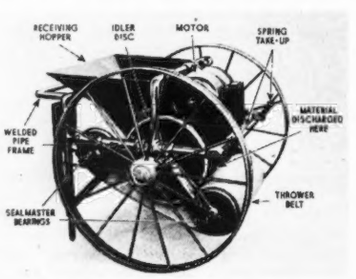


A MINE-CAR TRANSFER known as the Canton car transfer, for use on narrow gage track, is announced by The American Mine Door Company, Canton, Ohio. Designed to operate on a track gauge of 18 in. up to 24 in. and a rail minimum of 20 lb., this new unit is said to handle a car up to a maximum weight of 3,500 lb. In large tunnel operations no slabbing is usually required in the drift to install this car transfer and in small tunnels only slight slabbing is required to permit sufficient space for attachment of the transfer to the track for successful operations. The manufacturer states the units can be detached and made ready for moving to another location in two minutes by two men.

Features of this device are that it is possible to use a single track for loading or dumping jobs, and it eliminates the cost of driving one or more short crosscuts for car space while loading and the necessity of laying switches and track into these crosscuts. As the working face of any operation advances, the transfer will be advanced along the track and follow the loading operation.

Improved Loader

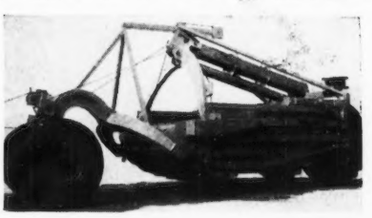
SOME IMPROVEMENTS are announced by the Stephens-Adamson Manufacturing Company, Aurora, Ill., in its loader and piler. All loaders are now equipped with the manufacturer's Sealmaster permenently sealed, self-aligning, pre-lubricated ball-bearing units. Due to the



dusty conditions under which these machines normally operate in loading bulk material materials, such as concentrates, into box cars and into piles, this improvement is said to result in a minimum of maintenance attention and greater power savings. A new, simplified means of adjusting the alignment of the belt is another improvement. As shown in the photograph, this loader operates with a fast-moving, dished belt. To facilitate adjustment of this alignment, a screw control now protrudes from the bearing through the front of the loader frame, so that to move the bearing forward or backward, and thereby adjust the alignment, it is only necessary to turn this control to right or left with an ordinary wrench.

Double-Bucket Carryall

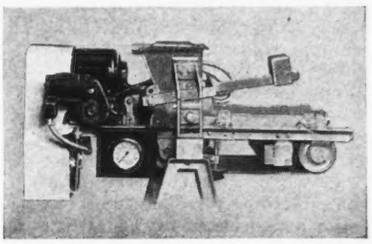
DESIGNED to give increased yardage with D8 tractor power, R. G. LeTourneau, Inc., Peoria, Ill., announces its new Model LU Carryall cable-controlled scraper with a struck capacity of 15 and a heaped capacity of 19 cu.yd. Because of its large capacity and easy loading, the Model LU can be used behind the



standard D8 tractor and loaded either with or without a pusher. This ability to work efficiently either with or without a pusher tractor is said to make this machine a valuable all-around unit adaptable either to long or short hauls and operation singly or in fleet. LeTourneau's patented double-bucket feature incorporated in the Model LU gives the effect of loading two small Carryalls successively. After the first bucket is loaded to capacity, it is permitted to travel back on rollers instead of being forced, thus reducing loading resistance and giving larger possible loads for expended tractor effort. The second or front section of the bowl is then easily heaped high with the D8 tractor power.

Weight-Recording Feeder

HARDINGE COMPANY, Inc., of York, Pa., announces a new weighing feeder, which incorporates a direct recording and totalizing attachment. Like the company's constant weight feeder, this new feeder employs the principle of a



compensating balanced belt on a pivoted frame, which is said to have been proved to be extremely accurate but very simple. In the present design the feeder is calibrated to read direct in tons, pounds, or kilograms, which reading is registered by a pointer on a meter. On this same meter are two weight-recording registers. One records the total accumulated weight and the other is a reset register which will record batch or time runs. The same system may be employed for use when the feeder is controlled remotely, and the recording instruments may be placed on a panel any distance desired from the location of the feeder. A feature of the arrangement is said to be its simplicity and accuracy, which is particularly advantageous in more or less cramped and dusty locations, but where close control and accuracy is required. The feed rates of various sizes of these feeders range from two or three pounds per hour up to 2,000 tons per hour. Size of feed ranges from fine products up to pieces as large as 12 in. diameter.

Improved Detachable Bit

SULLIVAN Machinery Company, Michigan City, Ind., announces design improvements in it detachable bits. These bits are designed so that greater areas of the cutting edges are located at the extreme outside diameter, where they are most needed, providing broad chopping and reaming edges. The bits are said to be made from electric furnace steel, forged, machined, heat-treated and finished to exact gage under automatic control to assure precision and uniformity. This technique is said to provide a bit "that holds its gage," resulting in

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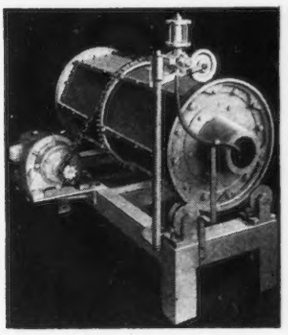

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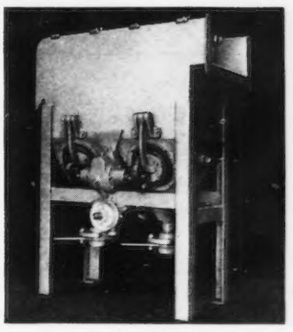
Patented



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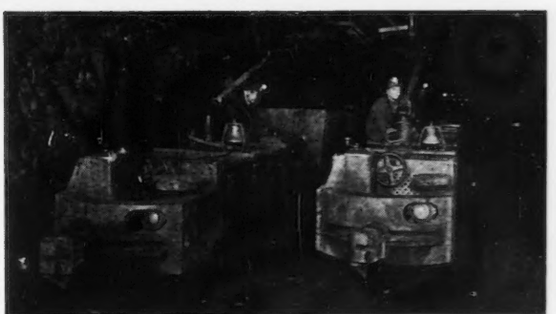

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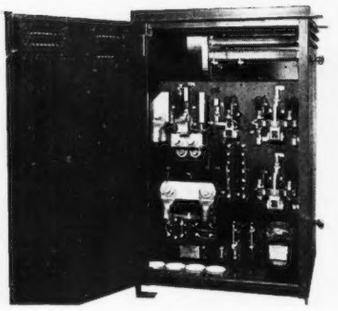
smaller losses in gage, fewer steel changes, fewer regrinds, elimination of rifling in holes, and no binding or catching of bits. Center-hole and side-hole types of bits are available. The rod, fitted with special rugged acme thread, bottoms into the bit so that the full force of the blow is not centered on the threads. Bit gages are $1\frac{1}{2}$ to $2\frac{3}{4}$ in. and rods in 2 ft. changes to 30 ft.

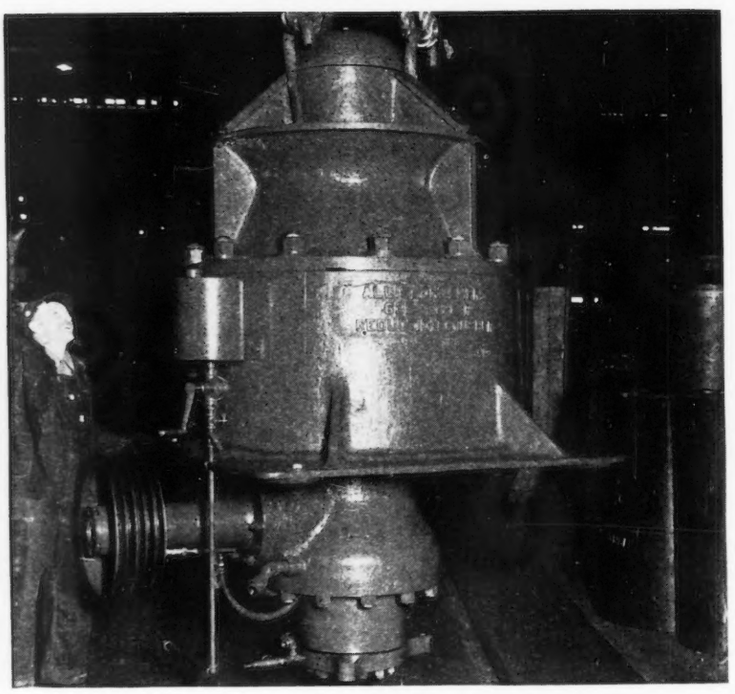
D-C Sectionalizing Switches for Mining Service

FOR REDUCING copper distribution losses, improving mining feeder voltage regulation during normal operation, and sectionalizing faulty sections of the feeder system during fault or overload conditions, a d-c sectionalizing switch for mining service has been developed by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. This unit is built in ratings up to 1,600 amp. at either 275 or 550 volts d-c. Mining often involves long feeders where short-circuits near the end of some of its branch circuits will not cause sufficient current to trip the feeder breaker at the substation. The sectionalizer is applied at the points where the branch circuits are taken from the main feeder. Trouble on one of these branches is quickly isolated so that normal service is undisturbed on the rest of the circuits.



This reduces load outages and saves time in restoration of service after an outage. The sectionalizer is housed in a substantial, drip-proof, steel box which can be locked up. Front and rear doors permit all parts to be easily inspected. The box is arranged for pole, wall, or floor mounting. The contactor is a proved circuit interrupter of strong and reliable construction and all parts are specially treated to withstand underground service.

Gyratory Crusher



ALLIS-CHALMERS Mfg. Company, Milwaukee, Wis., announces that it has added a larger-size gyratory, designated as its No. 636 Type "R" Crusher, having a 6-in. width of feed opening and a 36-in. diameter crushing head. Like the smaller size, the 322 Type R, it is said to operate at higher speed than other crushers of the gyratory type. It has a crushing stroke selected for a high-capacity cubically shaped product, and is suitable for handling large tonnages of ore. These units are shipped assembled, and ready to be set on their foundations without dismantling the gyratory crusher on arrival.

The spider and top shell are cast integral and are readily removable for replacing of its one-piece manganese-steel concave ring and head mantle. Adjustment for taking up liner wear is accomplished by means of an oil-filled hydraulic jack, which supports the main shaft and is located on the bottom plate. A safety feature permits automatic relief for tramp iron.

INDUSTRIAL NOTES

Eimco Corporation, Salt Lake City, announces the transfer of its branch office in New York City from 330 West 42d St. to 120 Broadway. Coincidentally, sales in the Eastern and Southern states will be in charge of P. M. Sheriger, who has been transferred to New York as district manager from his former territory in Montana and Idaho. Eimco's New York representation has been further strengthened by the appointment of **Henry W. Erickson** as district engineer, whose experience in the manufacture and use of crushing and grinding equipment will be at the service of mining companies in the East and South. Finally, Eimco will establish in New York a service department for the district, which will carry Eimco Finlay loader parts in stock, and provide competent service engineers for instruction and other assistance to operators.

Arc Welding Awards. A booklet entitled "We Who Work at Our Industrial Jobs" has been prepared by Ed. C. Powers, assistant secretary, The James F. Lincoln Arc Welding Foundation, in which he outlines a plan for participating in the Foundation's $200,000 award plan. Copies of the pamphlet will be sent on request to the Foundation, Cleveland, Ohio.

Sprage and Henwood, Inc., Box 446, Scranton, Pa. and **E. J. Longyear Company,** Foshay Tower, Minneapolis, Minn., have been appointed sales agents for the newly introduced Carboloy "Sinta-Set" diamond impregnated core-bits, according to an announcement by W. C. Weslow, manager of the newly formed mining division of Carboloy Company, Inc., Detroit.

Sullivan Machinery Company announces the appointment of The Bergstrom Steel Company, Ltd., of Los Angeles and Oakland, Calif., as distributors for its detachable rock drill bits.

The Babcock & Wilcox Tube Company, Beaver Falls, Pa., announces that the sale and distribution of its seamless steel tubular products in Argentina, Brazil, Paraguay, and Uruguay are handled by Babcock & Wilcox, Ltd., of London, England, through their offices in these countries.

Robins Conveying Belt Company announced the removal of its general offices from 15 Park Row, New York City, to 270 Passaic Ave., Passaic, N. J.

BULLETINS

Screw Classifiers. Western Machinery Co., 760 Folsom St., San Francisco, Calif., Bulletin S.C. 640 describes and illustrates features of the manufacturer's Wemco screw classifier. Pp. 8.

Blades for Bulldozers. Shovel Supply Co., 1300 McKinney Ave., Dallas, Tex. Folder describes line of blades designed to fit all makes of scrapers. Pp. 4.

General Catalog. Ohmite Mfg. Co., 4835 Flournoy St., Chicago, Ill. Catalog 40 is a handsome loose-leaf brochure describing and illustrating the manufacturer's line of resistors, rheostats, tap switches, chokes, and alternators. The book offers engineering data reference tables, dimension drawings, and a manual of resistance measurements. Data cover information on selection and application of the above-mentioned products. Pp. 96.

Propeller Pumps. Fairbanks, Morse & Co., 600 South Michigan Ave., Chicago, Ill. Bulletin 6360 describes and illustrates features of the manufacturer's line of Fig. 6360 mixed flow vertical propeller pumps. Pp. 6.

Air Conditioning Unit. Carrier Corporation, Syracuse, N. Y. Bulletin AC-129 describes and illustrates the company's line of air-conditioning units for domestic and industrial use. Tables of capacities, dimensions, ratings, and performance are given. Pp. 16.

Jaw and Roll Crusher. Smith Engineering Works, Milwaukee, Wis. Bulletin 264 E describes and illustrates the manufacturer's line of Wheeling jaw and roll crushers. Pp. 11.

V-Belt Data Book. B. F. Goodrich Co., Akron, Ohio. Bulletin 40 is a pocket-size book giving alphabetical listings of V-belt requirements for small and large industrial machinery. Pp. 170.

Tractors. Allis-Chalmers Mfg. Co., Milwaukee, Wis. Form MS 290 describes and illustrates features of the manufacturer's new "HD-7" 54-hp. diesel crawler tractor. Pp. 24.

Grizzly Feeder. Pioneer Engineering Works, Minneapolis, Minn. Form 536 describes and illustrates features of the company's grizzly feeder. Pp. 4.

Turbine Pumps. Fairbanks, Morse & Co., 600 South Michigan Ave., Chicago, Ill. Bulletin 6930 describes and illustrates the company's 6930 water-lubricated turbine pumps with open impellers. Pp. 6. **Angleflow Pumps.** Bulletin 5710 describes and illustrates the company's new line of pumps wherein the hydraulic stream flow, through the impeller, is at an angle to the axis of rotation. Pp. 15.

Fluorescent Lighting. Hygrade Sylvania Corp., Ipswich, Mass. Bulletin M-143 describes and illustrates the company's line of fluorescent lighting units for industrial uses. Pp. 21.

Dryers. Hardinge Co., Inc., York, Pa. Folder combined with bulletin 42 and 39 describes the company's Ruggles-Coles Dryers, Electric Ear, and countercurrent classifier respectively. Pp. 4.

Electric Lamps. Mine Safety Appliances Co., Pittsburgh, Pa. Bulletin M-9 describes and illustrates the company's line of special Edison permissible electric lamps. Pp. 4.

Rectifiers. Fansteel Metallurgical Corp., North Chicago, Ill. Bulletin F1-3 describes features of the company's selenium rectifiers. Pp. 6.

Chain Hoists. Coffing Hoist Co., Danville, Ill. Catalog G-3 illustrates in color and describes the company's advanced design hoists for many industrial uses and applications. Pp. 23.

Chart. McKenna Metals Co., 127 Lloyd Ave., Latrobe, Pa. Announces a 4x9-in. chart listing the horsepower requirements for cutting steel with Kennametal-tipped tools.

Transmission Belts. Hewitt Rubber Corporation, Buffalo, N. Y. Folder describes features of company's line of transmission belts for industrial uses.

Switching Equipment. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Dept. 8-N-48. Descriptive data 49-200 describes and illustrates the Type FP capacitor rack and switching equipment. Pp. 24.

Rotary Dryers. Louisville Drying Machinery Co., Louisville, Ky. Catalog describes and illustrates application of rotary dryers to metal and non-metallic fields. Blueprint designs and specifications for various types are included. Pp. 30.

Locking Nut. Security Metal Products Inc., 340 East Kalamazoo Ave., Kalamazoo, Mich. Folder describes features of the manufacturer's new locking nut. Pp. 3.

Electric Assay Furnaces. Denver Fire Clay Co., Denver, Colo. Bulletin 440 describes and illustrates features of the company's new electric assay furnaces. Pp. 6.

Scrapers. Bucyrus-Erie Co., South Milwaukee, Wis. Bulletin 4WS-3 describes and illustrates the company's new four wheel scrapers. Pp. 24.

Mine Safety Equipment. Mine Safety Appliances Co., Pittsburgh, Pa. Catalog SA is a loose-leaf and comprehensive description and illustration of the company's products of safety equipment for the mining industries. Electric cap lamps are described and layout specification drawings show floor plan of battery-charging racks. The book is well illustrated and hundreds of items are described. Pp. 142.

Water Purification. Worthington Pump & Machinery Corp., Harrison, N. J. Bulletin W-210-B26 describes and illustrates the manufacturer's process water softeners and pressure filters for all capacities. Pp. 8. Bulletin 210-B27 describes the company's hot-process water softener for boiler feed-water purification. Pp. 8.

Oil Circuit Breakers. Roller-Smith Co., Bethlehem, Pa. Catalog 3630 illustrates and describes the company's outdoor oil circuit breakers of 7,500-volt rating and 50,000-kva. interrupting capacity. Pp. 7.

Cost Calculators. R. I. LeTourneau Inc., Peoria, Ill. The field engineering department of this company has prepared a handy simple slide-rule calculator to rapidly compute probable costs in earth moving.

Elevator Links. Hadfields, Ltd., Sheffield, England. Folder 444 describes elevator, conveyor, and creeper links. Pp. 2.

Draft and Pressure Instruments. Republic Flow Meters Co., Chicago, Ill. Bulletin 801 describes and illustrates the manufactuer's line of draft and pressure instruments. Pp. 12.

V-Belt Power Transmission. Worthington Pump & Machinery Corp., Harrison, N. J. A 72-page "master manual" presenting methods of selection and precautions in using V-belt drives in order to obtain best results.

Automatic Pulp Sampler. General Engineering Co., 150 Pierpont St., Salt Lake City, Utah. Bulletin describes and illustrates the manufacturer's new automatic, electric-powered wet pulp sampler. Pp. 2.

Sink and Float. An illustrated brochure published by Huntington, Heberlein & Co., Ltd., Whitford, near Holywell, North Wales, England, describes and illustrates the H. H. sink-and-float process of separating mineral from gangue by gravity in a medium consisting of a suspension of finely ground solids in water. Ores suitable and unsuitable for the process are illustrated in color, and results of mill tests are given.

Circuit Breaker. I-T-E Circuit Breaker Co., Philadelphia, Pa. Catalog 2501 describes and illustrates the company's Type KSA and KSC automatic reclosing circuit breakers and relays. Pp. 16.

Sand Pump. Denver Equipment Co., Denver, Colo. Bulletin P10B illustrates and describes features of the company's vertical centrifugal sand pump. Pp. 4.

Coupling Units. United States Rubber Co., 191 Hudson St., New York, N. Y. Folder describes and illustrates application of its Cover-Tite coupling units. Pp. 4.

Mine Locomotive. General Electric Co., Schenectady, N. Y. GEA-3459 describes features of the manufacturer's new 15-ton trolley locomotive. 24 in. high. Pp. 4. **Resistance Welder Control.** GEA-2791 B describes the GE thyratron control for spot and projection welders. Pp. 8. **Reactrol System.** GEA-3436 describes eight ways to use the company's new reactrol system of temperature control. Pp. 4. **Photo-electric Relays.** GEA-1755 C describes features and uses of photo-electric relays and accessories. Pp. 4. **Time Switches.** GEA-2963 B describes Type TSA-14 time switches for control of A-C circuits. Pp. 4. **Oil Circuit Breaker.** GEA-2165-A describes and illustrates the FK 142 25,000-kva. breaker. Pp. 7.

Industrial Pumps. American Manganese Steel, Chicago Heights, Ill. Bulletin 940 describes and illustrates features of the Armsco-Nagle industrial vertical and horizontal pumps. Useful pump data are also included. Pp. 22.

Mine Car Transfer. American Mine Door Co., Canton, Ohio. Bulletin describes and illustrates manufacturer's narrow-gage track device for continuous loading of mine cars on a single track. Pp. 8.

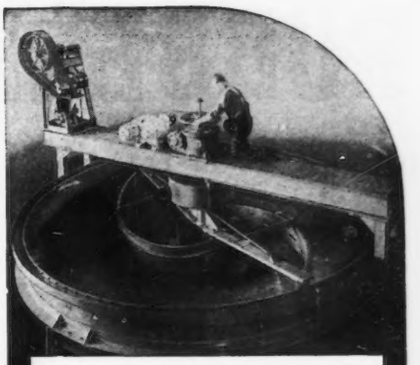
Bonding Mortars. Harbison-Walker Refractories Co. Farmers Bank Bldg., Pittsburgh, Pa. Bulletin describes the company's high temperature bonding mortars for industrial uses. Pp. 15. **Acid-Proof Brick and Tile.** Bulletin illustrates company's selection of standard 9-in. bricks of the 2½-in. series. Pp. 6.

Detachable Bits. Sullivan Machinery Co., Michigan City, Ind. Bulletin 87G. Describes and illustrates features of the manufacturer's detachable bits and bit grinders. Pp. 4.

Technical Information. International Nickel Co., 67 Wall St., New York, N. Y. Bulletin T-2 covers the subject of welding, brazing, and soft-soldering of monel, nickel, and Inconel. Pp. 31. Bulletin T-17 discusses the subject of fabrication of monel, nickel, and Inconel seamless pipe and tubing. Pp. 12.

Dust Control. Markley Dust Control System, Inc., 306 East 123d St., New York, N. Y. Leaflet describes the #1WD surface dust-control unit of two-rock-drill capacity. Pp. 1.

Removing Magnetic Particles From Suspension in Liquids. S. G. Frantz Company, Inc., 161 Grand St., New York, N. Y. Bulletin 15 describes and illustrates application of manufacturer's Ferro Filter that removes iron and steel products from suspension in liquids. Pp. 4.



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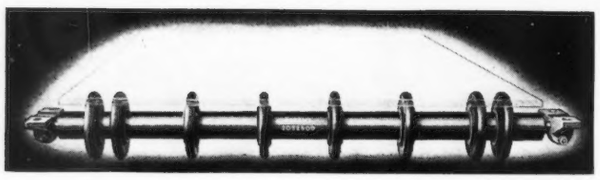
RUBBERDISC

RETURN IDLERS FOR BELT CONVEYORS

DE-ICE BELTS



RUBBERDISC Return Idlers were especially designed for handling abrasive, damp, or sticky materials. Use of Rubberdisc Idlers during severely cold weather has brought out another important feature . . . they keep belts free of ice.

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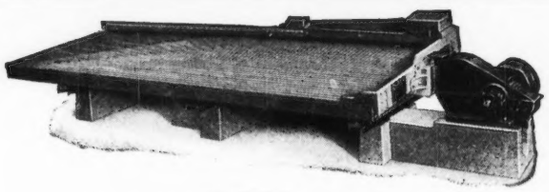

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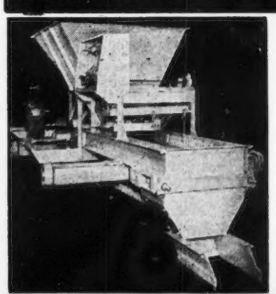

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INDUSTRY ORGANIZES
For National Defense

ALERT to what is happening in Europe, the American people are setting out to strengthen their defenses against aggression from any quarter. Already the government has laid down an initial program to that end.

The surest defense against aggression is the ability to resist it. If we are known to be well prepared we may avert attack. If we cannot avert it we shall be armed against it. But preparedness against war means preparedness to wage war.

And modern war is an industry. Like every other industry, it is a matter of men, materials and machines. Fighting men must be skilled workers, trained to use an arsenal of special tools and equipment that are just as diversified and just as essential to success as those of any other industry.

The plant, supplies and personnel of war must rival in efficiency those of any peacetime industry. For the stakes of success or failure in war are not paid in money profits or losses: they are paid in the lives and property of the people, in the security — perhaps the survival — of a nation.

* * *

Sound national defense calls first for a comprehensive program, carefully planned to back up a clear-cut policy as to what we expect to defend. Next comes the appropriation of funds to realize that program. These first steps are vital: they are up to government.

Then program and appropriations must be translated into performance. Native raw materials must be produced, processed and stored. Our meager supplies of strategic materials of foreign origin must be built up until we have accumulated ample stockpiles against the use and wastage of active war. And most urgent, because it is most complicated, raw materials must be manufactured into the innumerable items required to equip the modern army.

We of McGraw-Hill, living with American industry as we do, are keenly aware of the effort that will be required to produce the materials and equipment now needed to modernize our national armament.

Tanks and anti-tank guns, airplanes and anti-aircraft guns, machine guns and automatic rifles, trucks and tractors, destroyers and supply ships — these are but a few items from the endless inventory of military and naval equipment that we must produce by scores, hundreds and thousands, even to arm an Initial Protective Force, behind which we might rally our national resources for decisive effort.

Obviously the army and navy must count on American industry for an ample and continuous supply of this equipment, and industry must organize to produce it in vast quantities. This means the construction and adaptation of manufacturing, transportation and storage facilities, the organization of competent executive and technical staffs, the training of skilled craftsmen in numbers adequate to maintain exacting production schedules. All this, in itself, is an industrial organization problem of the first magnitude, but upon it is imposed still another and vital specification — *sustained speed.*

For time is the all-essential ingredient of modern war. It cannot be bought with any appropriation, however great; once lost, it cannot be recaptured; we must make effective use of it while we still have it. And at this juncture we have none to waste in fumbling, jockeying or experiment.

* * *

Two courses are open to carry out such a program.

1. We might adopt the totalitarian plan of nationalizing industry, conscripting the wealth and labor of all, and suppressing the normal incentives and management of industry in favor of the authority and control of government officials.

2. Or we can stick to the American way of achieving national unity and efficiency by intelligent cooperation between industry, labor and government.

There are those to whom the first will appeal as being the more direct. But I am convinced that most Americans will insist that the job be done in the American way. And in this preference the President, speaking for government, already has indicated his concurrence.

But effective cooperation in so complex and unfamiliar a task demands the utmost of mutual understanding and confidence from all concerned. Confusion of purpose and conflict of opinion are bound to arise — have, indeed, already arisen. Needs and capacities in many fields must be reconciled, relative priorities for various products must be determined, specific parts of the whole program must be allocated, supervised and coordinated with other parts. Government officials, smarting under the whip of urgency, must render quick decisions on highly technical matters, while industrial executives, masters of their own operating technique, must adapt themselves to arbitrary and unfamiliar requirements.

Under such conditions, many problems will arise that must be worked out between the men of industry and those of government. Some of them will be the more acute because of the restrictions under which industry has had to work during recent years—restrictions that have curbed not only the expansion of plant capacity, but also the development of improved processes and the supply of skilled workers. Now, from this sag in our industrial growth, many departments of industry must undertake an overnight expansion of capacity to meet the exacting time schedules of national defense. So industry must look to government for the cooperation that will enable it to expand its facilities promptly and yet write off in reasonable time its heavy emergency investments.

* * *

If we are to deal wisely with these situations, and many more we cannot now foresee, everyone engaged in any part of the defense effort must be willing and able at all times to get a fair understanding of the problems of the others. To help maintain such an understanding McGraw-Hill is peculiarly fitted.

1. By the organized exchange of views and information among our 24 papers, we can help to coordinate the thinking and practice of the 1,000,000 executives, technicians and operating men who are their readers, in matters that have to do with their part in the defense project.

2. Through constant contact with government agencies and the men of industry, our papers can interpret to industry the needs and policies of government and to government the problems and requirements of industry.

3. For the men of industry, each of our papers will expand its regular service as a clearing house of technical and operating data, with special reference to the needs of plants that are producing defense materials and equipment.

To forward these objectives we have set up within our company a National Defense Editorial Board. It is composed of the chief editors of our publications that serve the functions and industries that are of key importance to the defense effort. Made up of men intimately familiar with the personnel and practice of their industries, this board will stimulate and supervise the activities of McGraw-Hill papers insofar as they can contribute to the defense effort. It will outline basic editorial themes, directed to the forwarding of that project, to be adapted by each paper to the special needs of its specific field.

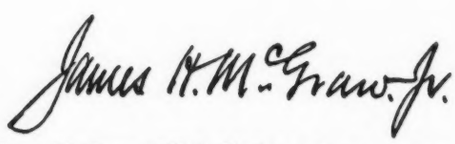
The board will keep close touch with industrial executives and technicians so as to keep abreast of new problems as they arise. It will maintain contact also with government defense agencies and keep our editors posted as to government objectives, plans and problems. Thus it will function as a link between the several governmental defense agencies and the McGraw-Hill editorial organization, and so help each editorial staff to develop a program best suited to the special problems of its industry.

* * *

In thus undertaking our part in an extraordinary industrial effort, we shall not neglect the normal concerns of American industry. So far as may be consistent with the paramount needs of national defense, production and distribution of the goods and services normally consumed by the American people must go on. The effort to mobilize industry for the national defense must be, in large measure, an additional job and an added burden.

That burden is within the capacity of the American people. But it will not be light. And if industry is to carry successfully its heavy share of that burden, it needs the full cooperation of every industrial function.

For more than seventy-five years, through peace and war, McGraw-Hill publications have served to interpret between the various departments of industry and between industry and the American people. Today, as we face these new problems, there is a new and urgent need for interpretation between the industries we serve and the government to which we all bear allegiance. It is fitting that McGraw-Hill should undertake this effort. To it I pledge every resource of our organization.



President, McGraw-Hill Publishing Company, Inc.

This message is appearing in all McGraw-Hill industrial and business publications, reaching over a million readers.

CHALLENGE TO INDUSTRY'S PATRIOTISM

Calls for Plain Speaking

IT is a pity that the greatest national defense effort in American history had to be made during a presidential election campaign. For a modern defense effort involves an intensely practical industrial project, while an election campaign involves an intensely emotional political propaganda. And those two don't mix.

That, as I see it, is the chief reason for the welter of claims and denials, charges and counter-charges that have been getting in the way of contracts for planes, tanks, guns and all the rest of the armament for which the American people are so nervously peering down the road.

We are told that the managers of industry, smarting and suspicious under the repeated attacks of government officials for some years back, have been reluctant to assume the abnormal risks of defense contracts without commensurate safeguards, and that the politicians who must authorize those safeguards have been reluctant to do anything that might be construed as letting down the bars for unscrupulous business men to exploit the national emergency. For the one, the business risks of full speed ahead have been too great; for the other, the political risks of full speed ahead have been too great. So we don't go full speed ahead.

This is not written to increase that clamor of recrimination on either side. On the contrary, it is an appeal for some decent and thoughtful consideration on the part of all concerned—consideration for the urgent needs of the nation, for the problems and responsibilities of both the politicians and the industrialists, for the elementary principles of prudent business management, and for the good opinion of the man on the street. He is neither a politician nor an industrial executive. But his hide and his pocketbook are at stake in the national defense program—and he knows it. He has a right to the low-down on what is going on. And if he is left in ignorance or deliberately deceived, for the sake of either political or business whoopee, the payoff will be mighty poisonous political medicine for the politicians and equally poisonous business medicine for the business men who may be responsible.

* * *

The plain stark fact, to be faced squarely by us all, is that the national defense program is an emergency project—a desperately urgent emergency project.

As in every emergency that confronts a democracy, we are harassed by a confusion of counsel. As always, some of the confusion arises from honest but conflicting judgments, some of it from ignorance or muddy thinking. But, unhappily, much of it reflects the deliberate purpose of self-seekers to fish in troubled waters—to capitalize the conjunction of a national emergency and a political campaign to boost their own interests. Already the charge that American business men are unpatriotic and interested only in profit has been put out as a smokescreen to cover up deficiencies for which business men are in no way responsible.

Now the man on the street finds it hard to see through this maze of excited contradiction. Not because he isn't smart—the average American can think straight enough *when he has the facts.* But in this case the facts are obscure and complicated—they have to do with matters that are strange to him. And to make it worse, at the height of his confusion, raucous voices constantly assail his ear with "simple" explanations of it all. But, as so often happens, most of these "simple" explanations make the matter a lot simpler than it really is.

* * *

Consider, for example, the cry that "industry refuses to get busy on national defense until its profits are guaranteed". Very clear and simple, to be sure; but also very false. The charge that American capital is "on strike" in the hour of national need. As silly as it is simple. The assertion that our manufacturers "won't even talk with a government anxious to place orders with them, without large financial concessions", and that "American corporate industry refuses to expand its resources for defense until it receives immunity from proper taxation". The resounding demand that we "conscript wealth as well as men"—whatever that may mean.

Particularly political has been the attack on the aircraft industry. It has been made to appear that aircraft manufacturers were instituting a sit-down strike because, in their greed for profits, they demanded more than 8%. Actually the 8% was not a net profit at all and the only concern of the manufacturers was to fight against incurring losses under the 8% limitation. And army and navy officers have sustained the aircraft manufacturers' viewpoint.

The air is full of explanations which, however simple they may sound, do not explain. And in most cases, I am convinced, the purpose of those who offer them is not to explain but to inflame. Those who try honestly to explain these issues from either side, find it impossible to do the job in such ringing phrases.

As I have said, our country has been caught short. As

a result, there are many reasons for the confusion and controversy. The plain fact is that we can produce our war equipment by only two means: (1) by converting the industries of peace into the industries of war, so far as that is possible; and (2) by building from scratch the new facilities we need to supplement them. In other words, we must create—with desperate haste—a new industry in America—an armament industry.

Right there is the crux of the problem that now confronts the industrialist sincerely trying to equip himself for his part in national defense. For this new armament industry is not the ordinary business risk against which he has learned to weigh the interests of his employees and his stockholders. It does not deal with familiar products and processes. It is not continuous—at least it has not been heretofore in this country—and it may fold up as suddenly as it has opened. It cannot hope to serve thousands of potential customers: it has but one sure customer—the United States Government—and wielding the sovereign power that customer can do just about as it pleases with respect to its needs and demands. Which means that not even this one is a *sure* customer.

* * *

No more unfair or deceptive charge ever has been leveled against American industry and American business men than the accusation of being unwilling to take the normal business risks of the defense program. The risks they are trying to minimize—they cannot possibly avoid them all—are very special and extraordinary risks indeed. So clearly is that true, that I doubt very much whether such questions and charges ever would have risen were it not for the fact we are engaged in a political campaign.

Already some of industry's great units have gone ahead with the building of new facilities, the purchase of special materials, and the actual production of armament in the face of all risks, gambling that their government eventually would work out some reasonable plan to protect them against excessive loss. Others, doubtless will follow suit.

But many other companies, for one reason or another, are not in position to do that. So before they begin to expand their facilities to handle defense contracts, they have asked their *only potential customer for those new facilities* to guarantee them—*not* excessive prices, *not* exorbitant profits, *not* immunity from taxation, as we are being told, but simply against the excessive losses that may result from very extraordinary conditions.

* * *

As this is written, it looks as though the legislation and the rulings necessary to accomplish this purpose soon will be forthcoming. Thoughtful and responsible officials of the government understand the situation and what is needed. But, unfortunately, their understanding and action will not quiet the professional business-baiters. So long as those gentlemen have their own interests to serve, so long as political excitement makes it easy to whip up public demand for a scapegoat to atone for disappointing progress with the defense program—just so long will the business-baiters find a receptive audience for their criticisms.

All of which suggests that business men must carry at this time a double responsibility, in addition to their obvious obligation to do the very best job they know how on their individual parts of the defense program.

The first of these added responsibilities is, of course, to avoid any possible basis for the charge that industry is exploiting the defense program in behalf of excessive profit, unfair treatment of labor or any other unworthy self-interest. The second is to see that the man in the street knows and understands all that I have tried to set down in the foregoing.

For the man in the street is deeply involved in all this. He is "in the street" only to the political orators. To the rest of us, he is the man in the factory, the man on the truck, and the man behind the orders that industry fills. In short, he makes up this living American industry on whom the politician's charges spatter. As an employee he has a stake in the solvency, the security, and the reputation of the very plants at which criticism may be directed. Knowing the facts, he can answer the critics so far as his own plant is concerned and can see how the same kinds of facts apply to all industry. If he is a customer, suffering inconvenience as a result of the plant's service to national defense, a knowledge of the facts behind the plant's problems will help to make him a defender rather than a critic of responsible business management. If he is a neighbor in the community, the facts will equip him to be an interpreter of industry's problems to the people of the home town.

* * *

In this national defense effort, business enters into a new partnership with government, but, more importantly, into a deeper partnership with the American people. It is more than ever essential that it take all of the American people into its confidence, beginning with the people in its plants and going out through the ranks of its customers and its community neighbors to show them that they have a common interest in seeing that the task of national defense is undertaken in the American way.

As we all know, there are in this country some people who would like nothing better than to see American industry fail in this supreme test of service to the nation. They will watch with jealous eyes every move of every company that is engaged on a defense job. They will disparage its achievements, exaggerate its shortcomings, and distort its motives. For they would like to make over American industry to their own pattern, and they'll never have a better chance to get started with it than has been opened up by the national emergency. Or so it looks to them.

So, great as are the business hazards of the defense program for the individual business man, even greater hazards are involved for American industry as a whole. But, knowing the temper of American industrial leadership as I do, I am confident that it will handle its defense assignment with credit to itself and with great advantage to the nation that it serves—whether in war or in peace.

To help in that supreme test is the opportunity and the privilege of the McGraw-Hill organization.

President, McGraw-Hill Publishing Company, Inc.

This message is appearing in all McGraw-Hill industrial and business publications, reaching over a million readers.

A Test for Dust Produced by Drilling With Steel Sprayed on Outside

TESTS were conducted at the Mount Weather testing adit of the Bureau of Mines on the effectiveness of spraying water along the outside of the drill steel compared with standard wet-drilling practice. The spray equipment used in the tests was designed primarily for the control, in quarries, of dust from dry drilling with solid type drill steel.

Spray equipment is made in sizes to fit different drill steel but is alike in design, the only difference being in the diameter of the ring and the number of spray holes. The device is made of cast steel and has a coating of Stellite on the inside edge that comes in contact with the drill steel. It looks like a garden spray, except that the spray holes point in only one direction.

Two sizes were used in the test herein reported. The larger one, used with 1¼-in. hollow, round steel for tests with the 3½-in. drifter, has an outside diameter of 4 in. and an inside diameter of 1⅜-in.; it is 1 in. thick. The device slips over the end, fitting loosely over the drill steel, and is held by gravity against the rock being drilled. Obviously, it can be used only on holes being drilled at an inclination below the horizontal. It sprays water along the outside of the drill steel and into the collar of the hole through twelve 3/32-in. holes in the inside edge; the water holes were drilled at an angle of 45 deg. to the axis. The outside edge was tapped in several places with standard ⅜-in. pipe threads for water-hose connection.

The smaller device, used with the hand-rotated, quarry plug drill of solid steel with ⅝-in. forged chisel bits, differed from the large spray only in the size of the inside diameter, which was ¾-in., and in number of spray holes (four instead of twelve).

Test procedure—The rock in the adit where the tests were made is a fairly uniform, hard, metamorphic basalt. The adit was bratticed off about 80 ft. from the face, and an opening 2 ft. square was left in the center of the brattice seal through which all of the return air had to pass. Ten-inch canvas tubing was carried 35 ft. in by the place where the test holes were drilled in the side of the adit. All holes drilled were about 5 deg. below the horizontal.

Five holes in each group were collared in the side of the adit with 2-in. bits before the tests were run. This allowed a uniform interval of time between the drilling of each hole, as no time was lost in collaring the next hole.

Each test was run by drilling 1 minute in each of the five holes with an interval of ½ minute between holes for changing drill steel. In the tests with the drifter a new 1⅝-in. detachable bit was used in each hole. This procedure was followed in all the tests with the drifter except in Test 3, in which the rock was too soft to allow the 1-minute drilling time per hole.

In the tests in which the quarry plug drill was used, a new ⅝-in. chisel bit, forged on solid steel, was used in each hole. The drilling time was 30 seconds per hole with an interval of 20 seconds between holes for changing steel.

The amount of air being circulated in the adit, measured at the 2-foot-square opening in the brattice, was about 1,000 cu.ft. per minute with the drifter stopped and about 1,300 cu.ft. per minute with the drifter running. The water flow through the drifter with a piece of drill steel in place was 2 g.p.m., and through the large spray it was 6.2 g.p.m. With water flowing through both the drifter and the large spray, the quantities were 1.8 and 6 g.p.m., respectively.

Two midget impingers were used in taking dust samples. One impinger was placed between the drill and the brattice 6 ft. from the holes being drilled, the other at the 2-ft.-square opening in the brattice seal, which was 22 ft. downstream from the holes being drilled.

Dust samples were taken continuously by the impinger near the drill from the time the first hole was started until the fifth hole of that group was completed. Dust sampling by the impinger at the brattice began 45 seconds after the first hole was started and continued until 45 seconds after the fifth hole was completed. The time required for the air current to travel from the drill to the brattice was checked with a smoke tube and stop watch.

After each group of five holes had

Table I—Dust Dissemination in Drilling Tests With a Water Spray

Test	Remarks	Type of Drill Machine	Size of Bit, In.	Drilling Time in Minutes	Cubic Inches of Rock Drilled	Water Used, g.p.m.	Ventilation, in c.f.m.	Dust Concentration in Millions of Particles per Cubic Foot of Air: 22 Ft. From Drill	Dust Concentration in Millions of Particles per Cubic Foot of Air: 6 Ft. From Drill
	Blank						1,050	1.8	2.6
1	Regular wet drilling	Drifter	1⅝	5	130.7	2.0	1,350	5.6	3.1
	Blank						1,050	2.0	2.4
2	Wet drilling plus spray	"	1⅝	5	165.9	7.8	1,350	2.3	3.1
	Blank						1,050	1.9	1.0
3	Dry drilling plus spray	"	1⅝	4.4	200.1	6.2	1,350	300.0	349.0
	Blank						1,050	1.7	1.4
4	Dry drilling	"	1⅝	5	153.5	None	1,350	1,131.0	1,472.0
	Blank (contaminated)						1,050	(a) 3.7	.8
5	Wet drilling	"	1⅝	5	70.0	2.0	1,350	2.7	2.3
	Blank						1,050	1.0	1.0
6	Dry drilling plus spray	"	1⅝	5	93.8	6.2	1,350	146.0	169.0
	Blank						1,050	2.3	.....
7	Dry drilling plus spray	Quarry Plug drill	⅝	2	2.5	2.0	(b) 1,100	2.9	.....
8	Dry drilling plus spray	"	⅝	2.5	5.2	2.0	1,100	2.7	.....
9	Dry drilling	"	⅝	2.5	4.4	None	1,100	218.0	.....

(*a*) Sample probably contaminated by water dropping from back when stopper was removed.
(*b*) Estimated 50 c.f.m. used by quarry-plug drill.

Table II—Comparison of Dust Per Minute Drilled and Per Cubic Inch of Rock Drilled

Test	Description of Test	Type of Drill Machine	Size of Bit, Inches	Total Volume of Air Passed During Sampling Time in Cubic Feet	Dust Concentration in Millions of Particles From Average Net Counts of Two Samples: Per Cubic Foot of Air	Total Disseminated	Per Minute Drilled	Per Cubic Inch of Rock Drilled
1	Wet drilling	Drifter	1⅝	9,450	2.15	20,317	4,063	155
2	Wet drilling plus spray	"	1⅝	9,450	0.50	4,725	945	27
3	Dry drilling plus spray	"	1⅝	8,640	323.00	2,790,720	634,255	13,947
4	Dry drilling	"	1⅝	9,450	1,300.00	12,285,000	2,457,000	80,032
6	Dry drilling plus spray	"	1⅝	9,450	156.50	1,478,925	295,785	15,767
7		Quarry plug drill	⅝	3,850	0.60	2,310	1,155	924
9	Dry drilling	"	⅝	4,070	215.30	876,271	350,508	199,152

been drilled, the place was ventilated for 20 minutes and then a blank dust sample was taken at each location.

Six men were in the vicinity of the drill while the tests were made. All dust samples were counted by the standard light-field method.

Results—Table I, which lists all dust samples taken by the two impingers, shows dust dissemination in drilling tests with a water spray. Table II gives average net counts and compares the dust disseminated per minute of drilling time and per cubic inch of rock drilled for the different tests. Test 1, regular wet drilling with the drifter, shows an average net dust count of 2.15 million dust particles per cubic foot of air. Test 2, wet-drilling as in Test 1 plus the spray, shows an average net dust count of 0.5 million dust particles per cubic foot of air. It appears from these two tests that the spray had some effect in controlling the dust disseminated by regular wet drilling.

Test 3, dry drilling with the drifter plus the spray, shows an average net dust count of 323 million dust particles per cubic foot of air. Test 6, a duplicate of Test 3, shows an average net dust count of 156.5 million dust particles per cubic foot of air. Test 6 was in harder rock on the opposite side of the adit. Test 4 was dry drilling with the drifter and shows an average net count of 1,300 million dust particles per cubic foot of air.

Comparison of Test 1 and Test 4 shows that 99.8 per cent less dust was produced by regular wet drilling than by dry drilling. Comparison of tests 3, 4, and 6 shows that when the spray equipment was used, 75.1 per cent less dust was produced in Test 3 and 88 per cent less in Test 6 than was produced in the dry drilling.

Test 7, dry drilling with a quarry plug drill plus the small spray, shows a net dust count of 0.6 million particles per cubic foot of air.

Test 9, dry drilling as in Test 7 but without the spray, showed a net count of 215.3 million dust particles per cubic foot of air.

Test 7 with the spray shows a reduction of 99.7 per cent of the dust obtained in Test 9.

Conclusions—The results of this series of tests show conclusively that spraying water along the outside of the drill steel should not take the place of regular wet drilling underground. Even if a method is devised whereby it may be used on holes at an inclination above the horizontal, far too much dust is disseminated even to consider its use instead of wet drilling. However, if a method is developed by which the device may be used on holes of any inclination, it might prove to be a valuable accessory to regular wet drilling in collaring and drilling the first 2 ft. of a hole. Tests show that the greatest amount of dust is thrown into the air of a working place in drilling the first 2 ft. of a hole.

The tests indicate that when the spray was used with a slow-cutting machine, such as the quarry plug drill, the device kept the dust dissemination within limits that are considered good underground practice.

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Accident Prevention at a Copper Smelter

CONCLUSION

Analysis of Accident-Prevention Methods—Many of the best features of the present accident-prevention program did not mature fully until after July, 1936, when it was decided that efforts to prevent accidents must be intensified if the safety program was ever to be a thoroughgoing success. The result was a careful analysis of accidents, and at a special July meeting of the Branch Safety Committee, factors contributing to accidents were diagnosed as follows:

	Influence Per Cent
1. Inadequate standards of safe practice	60
a. For intermediate, minor or unrecognized hazards rather than for recognized major hazards.	
b. For good supervision.	
2. Lack of safety consciousness among all workmen....	30
3. Personal inefficiency of some workmen	10

On this basis, codes of safe practice assumed major proportions as weapons against accidents. They not only appeared to be indispensable in combating cause 1, but they seemed valuable for increasing safety consciousness and the personal efficiency of workmen, thus striking at causes 2 and 3.

At the end of the period July, 1936, to July 1937, the smelter-division members of the Branch Safety Committee analyzed the relative effectiveness of accident-prevention methods employed during the twelve months. After studying all elements of the smelter accident-prevention program, this committee arrived at the conclusions set forth in the accompanying table.

The conclusions set forth in the foregoing apply only to the smelter program and the period indicated. A similar analysis of another safety program is likely to produce substantially different values. For example, at the operations of some companies, first-aid training as a means of increasing safety consciousness may supplant some factors in the preceding outline and may even carry a 40 per cent valuation. As a matter of fact, if an earlier analysis had been made at the Clarkdale smelter, first-aid training doubtless would have been accorded greater credit, but much the same effect is now obtained through the more enduring elements of the existing safety program.

Summary and Conclusions

The success of an accident-prevention program depends first on the whole-hearted determination of the official staff, from the top down, to eliminate accidents, and second on the recognition by the workman of the authenticity of this determination. For this purpose, the management of the Clarkdale smelter has developed a safety program combining a variety of elements of which safety committees, accident investigations, codes of safe practice, and systematic plant inspections are deemed the most effective. These and other elements of this safety program have been described in detail.

The present program is closely related to the programs of other branches and divisions of the Phelps Dodge Corporation and has been influenced also by ideas developed in safety programs of other companies. Operating codes have long been used to good effect by railroads, and these furnished the inspiration for the codes of safe practice developed at the Clarkdale smelter. It is interesting to note that some operating codes dealing with rail transportation are applied to all railroads, and it is possible that some of those prepared at Clarkdale could be used to good advantage at other smelters.

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[4] In time this factor is likely to be increased, since committeemen assignments are progressive.

Marketing Talc, Pyrophyllite, and Ground Soapstone

PURE TALC is a hydrous magnesium silicate ($Mg_3Si_4O_{10}(OH)_2$). Pyrophyllite, although it resembles talc in certain physical properties and uses, is a hydrous aluminum silicate ($Al_2Si_4O_{10}(OH)_2$) — like kaolin, except that kaolin has a somewhat different composition ($Al_2Si_2O_5(OH)_4$) and structure. Soapstone can be considered essentially an impure talc and when pulverized is used for many of the same purposes as talc. Massive, compact varieties of talc often are called steatite.

Properties—Talc and pyrophyllite are characterized by their softness (hardness on Mohs' scale, 1), their greasy feel, pearly luster, white color, and perfect basal cleavage. They have similar crystal structures, and this similarity explains the close resemblance of the two minerals in physical and chemical properties. Talc is a good electrical insulator, resists the action of most acids and alkalies, and has an exceptional heat-retaining capacity. Its specific gravity is about 2.7.

Most commercial tales are not pure but are mixtures of talc with other minerals occurring in the talc deposits and usually left in the product. Accessory minerals include dolomite, calcite, magnesite, serpentine, and tremolite, with occasional chromite, magnetite, and also traces of nickel and other constituents of basic igneous rocks. Tales produced in different localities differ in mineral contents and in physical as well as chemical properties. Some differences may exist in tales from different parts of the same deposit.

Commercial tales are classified as "hard" and "soft," "fibrous" and "flake," as well as according to screen size and color. "Fibrous" talc owes its structure mainly to needle-like tremolite and gritty tales to grains of dolomite or magnesite. Dark tales are likely to contain admixed serpentine or chlorite. Flake and soft tales only are relatively pure.

Occurrence—Commercial deposits of talc are found in much-altered ultrabasic intrusions, and in metamorphosed limestones. In the United States they occur in the Pre-Cambrian limestones of the Adirondacks, in the ancient metamorphosed sediments and ultrabasic intrusives of the Piedmont Plateau, and in the much-folded metamorphosed mountainous belt of the Pacific Coast. The only commercial pyrophyllite deposits in the United States are hydrothermal metasomatic replacements of dacitic and rhyolitic volcanic rocks in central North Carolina.

Uses—Except in the ceramic industry most of the uses of talc, pyrophyllite, and ground soapstone depend on physical other than chemical properties, and the minerals are not subject in their utilization to temperatures high enough to decompose them and initiate chemical changes.

Talc serves the paint industry principally as an extender, although in some paints it is the principal pigment. The fibrous talc (asbestine), a mixture of tremolite fibers and talc, is used largely in cold-water paint, the fibers of tremolite bonding the paint film. Flake talc and pyrophyllite are also incorporated in paints.

White, fine-grained tales are used for loading the better grades of paper. The low-priced, off-color, low-grade tales and pyrophyllite are used to form an inert, fireproof, weather-resisting coating for roofing papers.

Talc and pyrophyllite enter the ceramic industry in considerable quantities. Calcined talc ("lava") meets the special requirements of the electrical and refractory industries, being sold either as calcined sawed and machined block material or compounded from talc and silicate of soda, and then pressed into blocks and calcined. An important use of talc in the ceramic industry is in the preparation of sagger bodies. Considerable quantities of talc are sold to wall-tile and whiteware manufacturers, who also utilize pyrophyllite.

Various industries needing fillers utilize talc, pyrophyllite, and ground soapstone. Rubber manufacturers are said to take the largest amounts for use either as a filler or as a lubricant. Smaller quantities used by the makers of asbestos goods, floorings, wall plasters, insecticides, ropes, and plastics.

The lubricating properties of talc, pyrophyllite, and ground soapstone are utilized in many industries. Manufacturers of cup greases, foundry castings, rubber tires, bottles, and candy and users of box-nailing machinery and dies of various kinds consume small quantities.

Talc is the principal base in various toilet preparations, but this use is very small compared with total talc consumption. Some pyrophyllite has been used. Fine, pure-white material is required for this use.

Talc is used for abrasive or polishing purposes where the material to be polished is soft, such as peanuts or coffee beans, or where the dirt is to be removed from a soft underlying material, such as marble or lacquer.

Production—The annual world production of over 400,000 tons of talc, pyrophyllite, and ground soapstone comes from many countries, principally, however, from highly industrialized ones. Non-industrial countries produce only high-grade talc in small quantities for a limited market.

The United States has for many years been the outstanding source of these materials, producing in recent years over one-third of the world total and two to three times as much as any other country.

The United States produces most of its requirements in talc. This production comes from the eastern belt along the Atlantic Coast from Vermont to Georgia, and from the Pacific Coast States of California and Washington. The Eastern belt is by far the largest producing region, with New York the leading producing State. Production of pyrophyllite is confined to North Carolina.

Although there are usually 30 to 40 producers of talc, pyrophyllite, and ground soapstone in the United States in a given year, over half of the domestic production comes from not more than half a dozen concerns.

Sales—In the 3½ decades from 1880 to the World War, the total sales of talc, pyrophyllite, and ground soapstone rose from a few thousand tons a year in the early eighties to annual sales of nearly 200,000 tons. In the two decades since the World War, however, sales of these commodities have risen a little above the 200,000-ton level, but only on the crests of booms—in 1920, 1928 and 1929, and in 1936, 1937 and 1938. Increased use of talc in the ceramic industry during the last boom period carried the sales in 1937 to a new all-time record height of 229,999 short tons.

Prior to the recent depression the bulk of these materials came from New York and Vermont, but since 1932 increasing quantities have come from California and North Carolina. New

York is still the leading producing State. North Carolina has furnished all the pyrophyllite. Table I shows the sales of domestically produced talc, pyrophyllite, and ground soapstone, by classes, for the past eleven years (1928-38), covering the cycle from the crest of the 1929 boom to that of 1937.

Only a few thousand tons of domestic crude talc a year (3,956 to 8,878 short tons in recent years) goes to foreign markets, but there is an export trade in talcum powders valued at half a million to a million dollars a year.

Markets—The domestic market for talc, pyrophyllite, and ground soapstone is the largest in the world. It not only consumes most of the large domestic production of the crude materials but also imports some hundreds of tons annually. In 1933, a depression year, the domestic industries absorbed 162,315 short tons of talc, pyrophyllite, and ground soapstone, principally of domestic origin, and in 1937, during the following boom, they took 221,445 tons. This material is distributed as (1) crude talc, (2) sawed or manufactured talc, or (3) ground talc. The market takes 98 per cent of its consumption in the ground form. Less than 0.50 per cent is in the form of sawed and manufactured material. The balance is in the crude state. Table II shows the extent of the demand for each of these types of material in 1937.

Table II—Disposal of Crude Talc, Pyrophyllite, and Ground Soapstone in Domestic Market in 1937

Classification	Short Tons
Domestic crude sold	2,209
Domestic crude sold as sawed and manufactured	1,101
Domestic crude sold ground	217,811
Foreign crude imported	324
Total	221,445

Table I—Sales of Domestic Talc, Pyrophyllite, and Ground Soapstone, 1928–1938, by Classes

Year	Crude Short Tons	Crude Value	Sawed and manufactured Short Tons	Sawed and manufactured Value	Ground Short Tons	Ground Value	Total Short Tons	Total Value
1928	6,360	$48,031	936	$70,394	195,680	$2,419,569	202,976	$2,537,994
1929	11,228	87,820	473	140,928	208,082	2,399,914	219,783	2,628,662
1930	4,972	48,913	385	90,370	174,028	1,969,055	179,385	2,108,338
1931	6,673	47,382	181	51,740	156,898	1,753,350	163,752	1,852,472
1932	5,635	51,657	107	17,749	117,479	1,292,227	123,221	1,361,633
1933	5,985	46,553	246	31,686	159,792	1,653,643	166,023	1,731,882
1934	8,767	55,659	174	46,918	129,564	1,346,108	138,505	1,448,685
1935	10,725	57,259	841	63,211	161,150	1,727,585	172,716	1,848,055
1936	10,910	59,556	618	90,542	204,663	2,193,073	216,191	2,343,171
1937	11,087	52,750	1,101	111,680	217,811	2,397,323	229,999	2,561,753
1938	13,498	72,845	1,729	70,268	197,548	2,159,447	212,775	2,302,560

The largest markets for industrial-grade talcs are in the States east of the Mississippi River north of Virginia. California talcs of industrial grade are restricted to the Western States, high freight rates prohibiting competition in the Eastern area.

There are markets for talc, pyrophyllite, and ground soapstone in many different industries, principally, however, in the paint, paper, ceramics, rubber, and roofing industries, which in 1938 took 77 per cent of the total domestic sales. There are smaller outlets in the toilet preparations, fillers, foundry facing, and crayon industries. The electrical and refractory industries take calcined talc.

Table III shows the quantities and relative percentages of talc, pyrophyllite, and ground soapstone sold to the leading consuming industries, as reported by the producing company.

The markets for talc, pyrophyllite, and ground soapstone are shifting. For many years the paint, paper, rubber, and roll-roofing industries, in about the order named, were the principal consumers. In 1938, the ceramic industry, which formerly took a negligible quantity of those materials, took 14 per cent of the total and ranked second. The paint industry now comprises only about a quarter of the total market instead of one-half as formerly. The increased ceramic demand is due to the greater use of talc as a constituent of glazed wall-tile bodies.

Talc, Pyrophyllite, and Ground Soapstone Sold in the United States, 1936–1938, by Industries

Industries	1936 Short Tons	1936 Per Cent of Total	1937 Short Tons	1937 Per Cent of Total	1938 Short Tons	1938 Per Cent of Total
Paint	56,613	26	59,660	26	53,506	25
Ceramics	19,073	9	29,793	13	29,590	14
Paper	30,996	14	32,127	14	27,329	13
Roofing	25,160	12	23,551	10	27,607	13
Rubber	27,076	13	26,941	12	25,374	12
Toilet preparations	4,293	2	4,340	2	5,970	3
Foundry facings	2,781	1	3,228	1	2,511	1
Other	25,091	12	28,265	12	20,732	10
Not reported	25,108	11	22,094	10	20,156	9
Total	216,191	100	229,999	100	212,775	100

Most ground talc is sold today on the basis of grain shape and size, and color. Talcs are graded in sizes ranging from 20 to 325 mesh; in flake or fibrous shapes; and from white to dark in color. Only a few industries require talc in carload lots; the remainder are satisfied with from a few pounds to 4 or 5 tons a year.

Prices—Talc is a relatively low-priced commodity. The average value per ton of all grades of talc, pyrophyllite, and ground soapstone, f.o.b. mills, in the last ten years has ranged between $10.43 and $12.50 a short ton, dropping from the latter figure in 1928 to the former in 1933 and rising to $11.14 a ton in 1937. Tales suitable for manufacturing into blanks for insulators and gas burner tips ("lava-grade" talc) and for making crayons and pencils command the highest prices. High-grade "lava talc," lumps, may sell for as much as 6c. a pound, and the various forms of sawed talc are said to sell generally for at least $100 to $150 a ton, but some of these materials are reported at times to have sold as high as $800 a ton.

Prices on other kinds of domestic talc, pyrophyllite, and ground soapstone are generally much lower. Virginia crude is quoted at $4 a ton. Domestic ground tales, except toilet grade, normally range in price between $4 and $20 a ton, according to quality and fineness. Much domestic roofing talc, 20 to 50 mesh, is said to have been sold as low as $4 a ton f.o.b. mill. Quotations on finer-ground domestic tales, f.o.b. works, carload lots, were about as follows in 1939:

Virginia talc, 200 mesh	$4.75 @ $5.50
Virginia talc, 325 mesh	$6.25 @ $7.00
Georgia talc, 200 mesh	$6.00
Georgia talc, 300 mesh	$7.50 @ $10.00
Vermont talc, 200 mesh	$8.00 @ $14.00
New York talc, 325 mesh	$11.00 @ $17.00
California talc	$17.00 @ $20.00

Ground soapstone is generally quoted around $5 a ton for 200 mesh and up to $7 a ton for 325 mesh f.o.b. Virginia plant. Vermont soapstone quotations f.o.b. plant are about $10 to $12 a ton.

Ground pyrophyllite quotations range from $7.50 a ton in carload lots for some grades 200 mesh to $12 a ton for standard grade 325 mesh.

Imported tales range from $20 (or less) to as much as $85 a ton, the higher prices being for Italian and French talc. French talc sells in United States, ex dock, from $23 to $60, and Italian talc from $60 to $85. Manchurian talc sells in the United States for $30 to $40 a ton, a little off-color material selling as low as $20.

To be continued.

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Testing the Effect of Acid Mine Waters On Various Cements

ALTHOUGH many investigators have provided information on the strength and other properties of concrete, the published literature cites few data on the effect of mixing cement with acid mine waters or on acid resistance of concrete in contact with mine waters. Most of the reported work on the effect of impure waters has dealt with the resistance of cement specimens to "sulphate waters"—that is, waters or soils with a relatively high sodium sulphate content. The "Merriman test" is used commonly to determine the corrosion resistance of cements for 28 days, but it does not seem certain that a cement having a high sulphate resistance in the Merriman or similar tests necessarily will show correspondingly great resistance to the sulphates of iron and, particularly, to sulphuric acid, which usually are present in acid mine waters.

For a short time early in 1935 the opportunity to obtain at least some additional information on the effect of acid mine water on cements was presented by the Relief Works Division, which provided money for irregular and indefinite employment for several months. Purchase of apparatus or material was not permitted under this arrangement, and indefinite duration of the work, intermittent employment, and finally complete cessation of the work prevented planning for extensive investigation of this particular problem.

Under the restrictions indicated, the various kinds of cement were prepared and tested, for tensile strength only, by immersing small slabs in a high-acid mine water (8,000 to 14,000 p.p.m. total acidity). A series of four briquets was made of each of the different cements in the form and manner prescribed for tensile-strength tests by the A.S.T.M. standard specifications for portland cement (C77-32, sections 19-25 and 35-45, inclusive, 1933). Tensile strength was determined by a Riehle machine on specimens aged for 7 days and 28 days under conditions of curing and other requirements of A.S.T.M. standards.

Cements Examined for Tensile Strength—The cements tested were different brands of standard portland cements—one high early strength, one waterproof portland, one high silica, one high-alumina, and one said to be a "high-iron" cement. A special quick-setting, acid-proof chemical cement was made up in slabs but could not be tested for tensile strength because a special water-glass solution had to be used for the liquid ingredient, which prevented mixing and curing by standard methods. It was considered as a blank in the acid mine-water immersion tests and is referred to as O. One series of briquets was prepared for tensile-strength tests with tap water (Pittsburgh city water), one with dilute-acid mine water (400 p.p.m. total acidity), and one with high-acid mine water (8,570 p.p.m. total acidity). The tensile strengths reported in Table I are averages for all specimens that did not show abnormal variations in breaking under test. Those breaking under test were eliminated according to A.S.T.M. standards.

Results of Tests—The following observations may be noted regarding the data in Table I: The 7-day aging tests showed that dilute mine water (400 p.p.m. total acidity) gave greater tensile strength than tap water to all cements, although the high-alumina cement was not improved much.

The 28-day aging tests also showed increased tensile strength in all specimens except the high-alumina and high-iron cements, which were distinctly weaker than when prepared with tap water.

The 7-day aging tests showed that strong mine water (8,570 p.p.m. total acidity) gave greater tensile strength in all cements except the high iron, which is distinctly weaker. One standard portland cement (A) was not improved much.

The 28-day aging tests showed the same results, except that the standard portland cement (A) and the high-alumina cements are weaker and the waterproof portland cement is not much stronger.

The 7-day aging tests show lower tensile strengths for strong mine water than for dilute mine water in one standard (A) portland cement, the waterproof portland cement, and the high-iron cement.

The 28-day aging tests showed lower tensile strengths for strong mine water than for dilute mine water in two standard portland cements (A and B), the waterproof portland cement, and the high-alumina cement. The high-iron cement, however, seems to have been distinctly improved by the strong mine water, although the 28-day tests for the high-iron cement gave lower results for dilute mine water than with tap water.

Neat Cement-Slab Tests—Proper methods for testing suggested the immersion in mine waters of different acidities of enough tensile and compression strength standard specimens to allow withdrawal and testing at intervals of sets of at least three of each type. However, the limitations mentioned in the introduction did not allow this procedure. As a matter of interest, it was believed worth while to immerse test slabs in a high-acid mine water and let them remain until one or more obviously had failed. Accordingly, slabs of neat cement were prepared in dimensions of about 3½x6 in. and ½ in. in thickness, as specified by A.S.T.M. standards to which reference has been made. These were one to three mixtures of the several types of cement and standard Ottawa sand. Water was added in amounts shown previously in preparation of tensile-strength briquets to be necessary to produce neat cements of normal consistency, as indicated by the Vicat needle. One set was prepared with mine water of 400 p.p.m. total acidity (dilute) and another with mine water of 2,300 p.p.m. total acidity (strong). By means of wood racks these specimens were immersed in a pool of mine water through which was bypassed barely enough regular mine-drainage discharge to flow. Thus, the standard

Table I—Tensile Strength of Cements

No.	Type of Cement		Tensile Strength, Lb. per Sq. In. Tap Water	Acid Mine Water 400 p.p.m.	Acid Mine Water 8,750 p.p.m.
1	Standard portland A.	7-day	257	274	261
	Standard portland A.	28-day	441	456	414
2	Standard portland B.	7-day	236	265	283
	Standard portland B.	28-day	365	412	400
3	Standard portland C.	7-day	255	316	325
	Standard portland C.	28-day	393	425	474
4	High early strength portland.	7-day	290	376	403
	High early strength portland.	28-day	414	454	504
5	Waterproof portland.	7-day	241	280	253
	Waterproof portland.	28-day	339	353	341
6	High silica (portland-puzzolan).	7-day	226	242	254
	High silica (portland-puzzolan).	28-day	359	378	388
7	High alumina.	7-day	296	303	310
	High alumina.	28-day	372	353	320
8	High iron.	7-day	276	298	263
	High iron.	28-day	432	404	453

sulphate resistance conditions of the Merriman test, in which the indicated "make-up" acid salt is added to beakers containing the specimens in the laboratory, were maintained as nearly as possible under field test conditions.

The tests extended over a period of 510 days from June 26, 1935, until they were discontinued on Nov. 17, 1936. As it was impossible to visit the site frequently or regularly after the first few months, when no changes in the slabs could be observed, the possible effect of freezing during the winter is unknown. In fact, it is not known whether the pool froze during this period, but during some normally cold weather it was not frozen. A visit on Nov. 17, 1936, disclosed one specimen softened completely to about the consistency of toothpaste. Except for a shell of iron oxide formed by the mine water, this specimen would have been washed away completely and was barely able to stand up under its own weight during very careful removal. All test slabs were removed at this time, examined carefully, and photographed.

With the exception of slab O, which was only slightly discolored, all slabs showed definite signs of deterioration, although several prepared with dilute mine water were not greatly affected. Only one slab (C, the high-silica cement slab) stood out above others in the strong mine-water series (A to H) as apparently acid-resistant.

Failures consisted mainly of warping, spalling, and, in some instances, swelling; the outstanding example of swelling is S, the slab referred to as being completely softened. Its counterpart, G, prepared with strong mine water, was not affected nearly so adversely. As six of these slabs (A to D, inclusive, and K and L) originally were wider than the others, the difference in height (visible) is not due to the greater swelling that seemed to occur mainly along the least dimension —namely, thickness. To a certain extent, the effect of acid mine water on most slabs was indicated by the relative thickness of a white, slimy coating that seemed to mark the depth to which destruction of the original cement constituents had progressed. Petrographic examination of this white slime (specimen S was composed entirely of this slime) indicated that it was largely hydrated calcium and aluminum sulphates; spectrographic examination showed that it was composed of magnesium, silica, aluminum, and calcium present in that order of magnitude.

Visual examination required some system for comparative classification of results, and such a system necessarily was arbitrary. Considering the essentially unaffected chemical cement (O) as "very good" and the worst slab, a waterproof portland cement, as "very bad" (S), these slabs are listed in Table II in the same order as in Table I.

In so far as visual observation alone is concerned, these slab tests indicate, with one exception (F and S, Table II), that concrete prepared with acid mine water having a total acidity of about 2,300 p.p.m. can be expected to deteriorate more in a given time than if water of much lower acidity is used for mixing. This observation is almost directly contrary to the effect of higher-acid water on tensile strength. The slab tests indicate that a high-silica or portland-puzzolan type cement has greater resistance to extreme conditions than other types of cements tested, except the special acid-proof cement. This is indicated by the fact that slab C, Table II, was the only one of the high-acid series (except acidproof slab O) not in bad condition when removed after immersion in high-acid mine water.

Table II—Slabs After Immersion in High-acid Mine Discharge

	Prepared With Strong Mine Water (2,300 p.p.m. acid)		Prepared With Dilute Mine Water (400 p.p.m. acid)	
Type of cement	Letter	Condition	Condition	Letter
Standard portland A	A	Bad	Bad	K
Standard portland B	D	Bad	Good	N
Standard portland C	G	Bad	Fair	T
High early strength portland	B	Bad	Bad	L
Waterproof portland	F	Bad	Very bad	S
High silica (portland-puzzolan)	C	Fair	Good	M
High alumina	E	Bad	Bad	P
High iron	H	Bad	Good	R

When mine water of relatively low acidity (400 p.p.m.) was used for mixing, greater differences in acid resistance were observed easily. The three standard portland cement ranged from good to medium (fair) to bad (see samples N, T, and K, Table II); a waterproof portland cement was very bad, and the others were either good or bad.

Conclusions—Although the work reported is far from comprehensive, some tensile-strength tests were made on six different types of cement, but including three brands of one type (standard portland) to total eight cements. Exposure tests have been made on these and on one additional special acid-proof cement. These tests indicate that:

1. The use of acid mine water instead of water of the quality recommended by most cement manufacturers for mixing concrete does not necessarily decrease tensile strength and may increase it if the standard 7-day and 28-day aging tests are accurate final measures of that property. These observations agree in general with another published report of similar nature.[1]

2. The 7-day specimens showed higher tensile strength in all instances when mixed with low-acid mine water (400 p.p.m. total acidity) than when tap water was used.

3. All but one of the 7-day specimens mixed with higher-acid mine water (8,570 p.p.m. total acidity) were higher in tensile strength than those mixed with tap water.

4. All but two of the 28-day specimens mixed with low-acid mine water showed higher tensile strength than those mixed with tap water.

5. All but two of the 28-day specimens mixed with higher-acid mine water also showed higher tensile strength than those mixed with tap water.

6. Comparison of the specimens mixed with acid mine water reveals that five of the eight series of cement specimens aged for 7 days had higher tensile strength with the higher acid water (2B, 3C, 4, 6, and 7, Table I) whereas only four of the eight series of specimens aged for 28 days showed this improvement (3C, 4, 6 and 8, Table I).

7. Although the data seem to indicate increased tensile strengths for specimens of most of the cements tested when prepared with acid mine water instead of tap water, the tests do not reveal whether the actual improvement was due to accelerated setting (development of higher early strength in tension) only and might be reversed by long-term aging in mass concrete.

8. As in the tensile-strength tests, the small slabs of neat cement immersed in high acid water appeared to the unaided eye to differ considerably in acid resistance of the various types of cement. However, visual evidence seemed fairly conclusive that higher-acid mixing water (2,300 p.p.m. as compared to 400 p.p.m. total acidity) caused more rapid deterioration than the lower-acid mixing water. (See series A to H, inclusive, and series K to R, inclusive, Table II). A waterproof portland cement seems to be an exception. The high-alumina cement was about equally bad under both conditions.

9. The data and observations reported here seem to indicate that more comprehensive investigation of the effect of acid mine water on cement and concrete would be productive of interesting as well as valuable practical information.

Excerpted from Report of Investigation 3487, by R. D. Leitch and J. G. Calvert'ey, Bureau of Mines, Washington, D. C.

[1] Abrams, Duff A.: "Tests of Impure Waters for Mixing Concrete": Lewis Institute Bull. 12, September, 1924; Proceedings of American Concrete Institute, 1924.

Tramways in the Metal-Mining Industry

Construction and Operating Costs

▶ THIS IS THE SECOND *of two papers dealing with the construction and use of aërial tramways in the metal-mining industry. The first paper*[1] *described aërial tramways in a general way and discussed the engineering principles used in tramway design. The purpose of this paper is to give a more detailed description of equipment and material and to discuss construction and operating costs. The present paper is based largely on data from actual operations. Metal-mine operators from many parts of the United States, Canada, Alaska, and Mexico contributed liberally.*

Construction Costs

COSTS of tramway construction probably are more difficult to estimate than those of most other types. Design is influenced largely by topography and climatic conditions. General conditions affecting costs vary so greatly that every individual line, and in some instances, every individual structure, is a problem in itself. Cost of materials and equipment for a given design can be estimated easily and accurately. Erection costs, however, are more difficult to forecast. The cost of delivering the material and erecting a structure at one part of a line may be twice or even three times as great as for a structure of identical size and design at another part of the same line. Such extreme range in labor costs for jobs that appear identical may be the rule rather than the exception in situations of rough topography where aërial tramways find their greatest field of usefulness in the metal-mining industry.

Preliminary Costs — Preliminary costs may be considered to include all costs that accrue before actual construction begins. These expenses may be negligible or may amount to 15 per cent or more of the total cost of the tramway. Generally, however, they are much less than 15 per cent.

Surveying—A tramway survey comprises running a center line and determining horizontal and vertical distances to the nearest one-hundredth of a foot, and making an accurate topographic survey of each structure location. The cost of this survey covers field and office work and incidental items. Short trams in countries with plane topography may be built after an inexpensive survey. In countries of rough topography, however, surveying costs may be considerable. Months of preliminary surveying are sometimes necessary to find the most favorable route. This is often so where angle stations are required. An example of this is the tramway of the Silbak Premier Mines, Ltd., at Premier, B. C.[2] Preliminary surveys for this tramway were initiated the season before construction began and the surveying cost was approximately $550 a mile.

Right-of-Way — Right-of-way costs include any legal or other expenditures required to get permission to build a tramway on private or public property. It may be difficult and costly to procure a right-of-way in certain thickly populated areas. In most metal-mining districts in the western United States, however, right-of-way costs are negligible. Aërial tramways are less damaging to property than any other means of surface transportation. Even when they cross cultivated fields, the damage is comparatively slight and in many instances negligible. Only from 100 to 200 or 300 sq.ft. of ground is required for each tower or support. If the topography permits long spacing of supports, the property damage is no greater than that of a power transmission line.

The cost of clearing right-of-way is high in heavily timbered countries. In certain parts of the western United States, Canada, and Alaska and in many tropical regions, clearing of right-of-way may cost as much as $2,000 or more per mile. Generally, a strip 50 ft. on each side of the center line, or a total of 100 ft., is cleared. If the timber is tall it may be necessary to clear a wider strip so that the tallest tree at the edge of the clearing would not damage the tramway in falling. Clearing costs for the Premier tramway and the Porter-Idaho tramway,[3] both of the Silbak Premier Mines, Ltd., of Premier, B. C., were approximately $2,000 and $1,800 per mile, respectively.

Engineering Design — Nearly all aërial tramways are designed by private consulting tramway engineers or by the engineering staffs of tramway manufacturers. Exceptions are tramways built from old or used equipment. A number of successful lines of this latter kind have been built at small to medium-size metal mines in the western United States by mining engineers who did not profess any special knowledge of tramway engineering. Some manufacturers will supply material according to the specifications of private consultants; others, however, frown upon the practice. Regardless of what the arrangement may be between customer and vendor, engineering costs are paid by the customer in the end, either directly or indirectly. Some companies make a direct charge for their engineering services, whereas others pass the cost on to the customer in other ways. The first of these is the more businesslike and probably is more satisfactory in the end.

Consulting tramway engineers often will contract to design a tramway, bargain for material and equipment in the most favorable markets, and supervise construction. By such an arrangement, engineering and supervision costs sometimes can be cut to a minimum. It is not suggested, however, that this is always the best arrangement. The question as to whether a private consultant should be employed in this capacity or in an advisory capacity only depends on many things, but perhaps more on the personalities involved than on any other factor.

There are relatively few experienced consulting tramway engineers; they are located in such widely separated places as New York, N. Y.; Chicago, Ill.; Dallas, Tex.; Denver, Colo.; and San Francisco, Calif.

Transportation—The costs of transporting construction materials require little discussion. In this paper, they will be considered to include the costs of transporting material and equipment from the source of supply to the general site of the tramway, but not the cost of distributing them to the various places where they are to be used ultimately. It is thought to be more logical to include the latter in erection or installation costs. In general, transportation costs would include freight charges by rail or water, or both, from the source of supply to the nearest unloading station, and a trucking or draying charge from the unloading station to the general site of the tramway.

Certain materials for construction

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[1] Metzger, O. H.: "Aerial Tramways in the Metal-Mining Industry." Part 1: Bureau of Mines Inf. Circ. 6948, 1937, pp. 32.

[2] Pitt, Dale L.: "Aerial Tramway Construction and Operation." *Trans.* C.I.M.M., 1930.

[3] Pitt, Dale L., Work cited in footnote 2.

Table I—Comparative Properties of Timber and Steel[a]

	Timber						Steel			
				Cost per Linear Foot (c)						
Member	Size, In.	Allowable Compressive Strength, Lb. (b)	Weight Per Linear Foot, Lb.	At $30 Per 1,000 Board Feet	At $40 Per 1,000 Board Feet	At $50 Per 1,000 Board Feet	Size and Shape, In.	Allowable Compressive Foot, Lb. (b)	Weight Per Linear Foot, Lb.	Cost Per Linear Foot at $120 Per Ton (d)
Saddle beams	8 by 10	60,000 to 100,000	22.2	$0.200	$0.267	$0.334	6 by 2 channels	68,700	13.0	$0.78
Legs	8 by 8	48,000 to 80,000	17.8	0.160	0.213	0.267	4 by 4 by ½ angles	67,500	12.8	0.770
Legs	6 by 8	36,000 to 60,000	13.0	0.120	0.160	0.200	3½ by 3½ by ⅜ angle	45,000	8.5	0.510
Legs	6 by 6	27,000 to 45,000	10.0	0.090	0.120	0.150	3 by 3 by ⅜ angle	38,000	7.2	0.430
Braces	3 by 8	18,000 to 30,000	6.7	0.060	0.080	0.100	2½ by 2½ by ¼ angle	21,500	4.1	0.246
Legs	3 by 6	13,500 to 22,500	5.0	0.045	0.060	0.075	2 by 2 by ¼ angle	17,000	3.2	0.192

(a) American Institute of Steel Construction, 2d ed., January, 1934. (b) Allowable compressive stress for timber, 750 to 1,250 lb. per sq. in; steel, 18,000 lb. per sq. in. (c) Costs based on rough-dimensioned unframed lumber. Add $35 to $50 per 1,000 board feet for framing and erecting, depending on availability of skilled labor. (d) Cost based on fabricated steel prepared for erecting. Add 10 to 15 per cent for erecting.

Table II—Cost of Labor and Material Required for Steel and Timber Tramway Structures

						Cost of Material			Framing and Erecting Costs (a)		
Structure	Fig. No.	Height, Ft.	Structural Material	Board Feet	Weight, Lb.	Unframed Timber at $40 Per 1,000 Board Feet	Bolts for Timber Structures	Fabricated Steel at $120 Per Ton	Timber $50 Per 1,000 Board Feet	Steel, 10 Per Cent of Cost of Fabricated Material	Total (b)
Pyramid tower	1	20	Timber	850	2,700	$34.00	$6.50	.....	$42.50	.....	$83.00
Pyramid tower	..	30	Timber	1,400	4,500	56.00	8.75	.....	70.00	.....	134.75
Pyramid tower	..	40	Timber	2,100	6,700	84.00	13.00	.....	105.00	.....	202.00
Pyramid tower	3	20	Steel	.....	2,240	.....	.....	$134.40	.....	$13.44	147.44
Pyramid tower	..	30	Steel	.....	3,660	.....	.....	219.60	.....	21.96	214.56
Pyramid tower	..	40	Steel	.....	5,360	.....	.....	321.60	.....	32.16	352.76
Through tower	2	..	Timber	1,250	4,000	50.00	7.00	.....	62.50	.....	119.50
Through tower	..	..	Timber	1,750	5,600	70.00	9.50	.....	87.50	.....	167.00
Through tower	..	..	Timber	2,300	7,400	92.00	15.00	.....	115.00	.....	222.00
Tension Station	4	..	Timber	6,500	20,800	260.00	35.00	.....	325.00	.....	620.00
Station	5	..	Steel	.....	18,000	.....	.....	1,080.00	.....	.....	1,188.00

(a) Framing and erecting costs depend on availability and quality of skilled labor. Costs shown are based on erection at reasonably favorable locations. On steep, rocky hillsides, the costs may greatly exceed those shown. (b) Includes cost of structure only. Foundations, saddles, sheaves, etc., are extra.

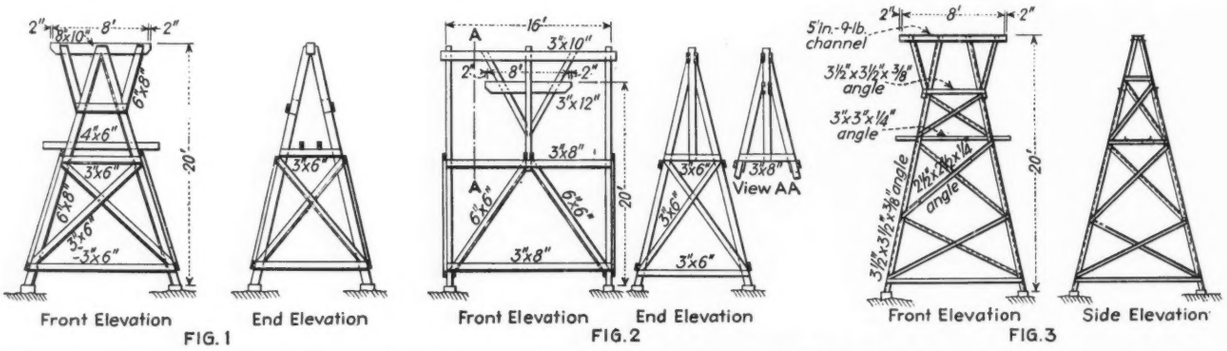

Fig. 1 . . . Pyramid tower, timber construction. Fig. 2 . . . Through tower, timber construction. Fig. 3 . . . Pyramid tower, steel construction

purposes generally can be purchased locally, whereas others must be obtained at the source of supply and sometimes shipped thousands of miles to where they are to be used. This may sometimes determine the type of construction to employ.

Material: Timber—Timber is generally the handiest and most easily obtainable material for structural purposes. The coast variety of Douglas fir is the most satisfactory timber for any kind of construction work in the western United States. Other kinds that are satisfactory are the Rocky Mountain variety of Douglas fir, sometimes called red spruce, and Ponderosa or Western yellow pine. A good grade of timber of one or more of these varieties is always available in almost any part of the western United States at prices ranging from $30 to $50 per thousand board feet. Any good grade of structural timber that has been properly seasoned will last the life of the tramway in most western climates. Tramway towers built more than 40 years ago in southwestern Colorado are still standing in a fairly good state of preservation. Many of these were built from a medium grade of Englemann spruce, which is inferior in its weather-resisting qualities to the varieties named in the foregoing.

In designing timber tramway structures the tendency is to use much heavier material than is necessary; 8x8-in. timbers often are used for the main part of structures for which 6x8-in. would serve just as well. Six by six-inch timbers sometimes are used for building all line structures of heavy-duty systems used in the construction industry. Inasmuch as these are temporary lines, it is possible to use lighter construction than otherwise would be advisable. The fact, however, that some are of larger capacity than the average heavy-duty mine tramway leads to the belief that 6x6-in. select timbers might be suitable even for permanent lines of moderate capacity.

The amount of timber required to build a tower of a certain height depends on the type of tower as well as the size of timbers. Figs. 1 and 2 are designs of two towers, one of the pyramid type and the other the through type. Table I shows the cost and weight per linear foot and the compressive strength of various sizes of timber suitable for building such structures. For comparison, the same data are shown for a number of steel sections.

Table II gives the amount, cost, and weight of timber or steel required to build the structures shown in Figs. 1, 2, 3, also in 4 and 5 which will be presented in Part II. The structures shown in Figs. 3 and 5 are of steel construction; all of the rest are of timber construction.

(To be continued)

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Tramways in the Metal-Mining Industry

Part II

TENSION stations, anchor stations and rail sections generally are built from the same kind and size of material as the supporting towers. Heavier timbers sometimes are used for the center posts than for the outside posts of tension and anchor stations. Figs. 4 and 5 show the designs of typical double-tension stations in timber and steel, and Table II (see *E.&M.J.* for April, page D 112) shows the amount, cost, and weight of material required. About 20 per cent less material is required for a double anchor station. Rail sections vary so greatly in length, height, and design that no attempt is made here to show the amount or cost of material required to build them.

Size and plan of loading and discharge terminals depend to a great extent on topography and bin capacity required. If the tram is to be used for transporting timbers and supplies from discharge terminal to loading terminal, extra floor space must be provided for storage and handling; track for mine cars and extra switch rails must also be considered. At many metal-mining plants the loading terminal may be part of a crushing plant and the discharge terminal a part of a mill. At such plants, terminal costs may be reduced greatly.

Steel—Steel is preferred to timber for structural purposes by many tramway engineers. For the same strength it is lighter than timber and consequently the erecting costs are less. Total over-all costs, however, are considerably higher. It is seldom possible to purchase structural steel locally. Most rolling mills and fabricating plants are in the East and Middle West, with a few in the Rocky Mountain region and the Pacific Coast.

It is customary when building with steel to submit drawings of each structure to a fabricating plant. The members required are cut and punched according to the drawings and shipped to the customer ready for erecting. Sometimes the steel is purchased direct from the rolling mills and fabricated at a makeshift plant on the ground where it is to be used. It is claimed that a saving may result from this latter practice.

Angles from 3x3x$\frac{3}{8}$-in. to 4x4x$\frac{1}{2}$-in. are suitable for the main structure work on tramways with a capacity up to about 60 tons per hour. Lighter angles are used for braces and 3x7-in. channels for saddle beams. Prices, unit weights, and compressive and tensile strengths of various sections are shown

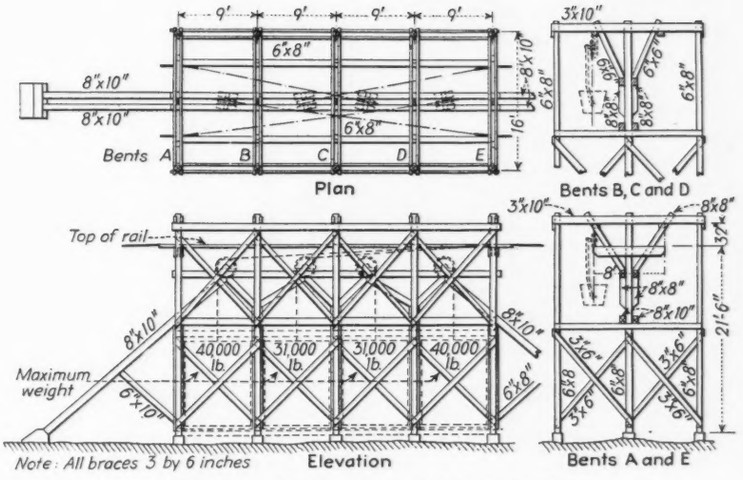

Fig. 4 . . . Tension station, timber construction

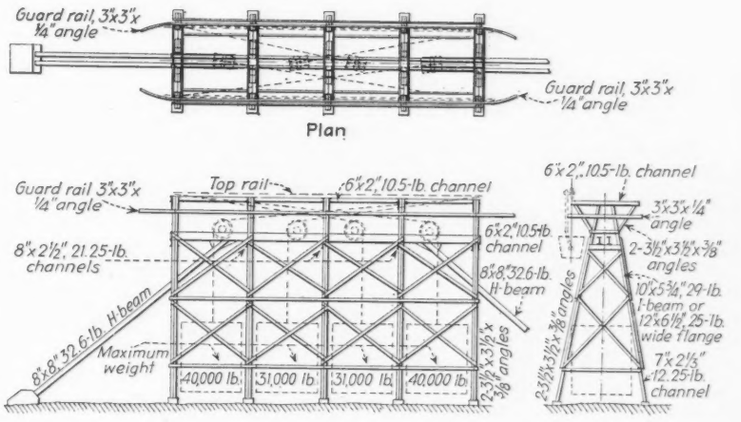

Fig. 5 . . . Tension station, steel construction

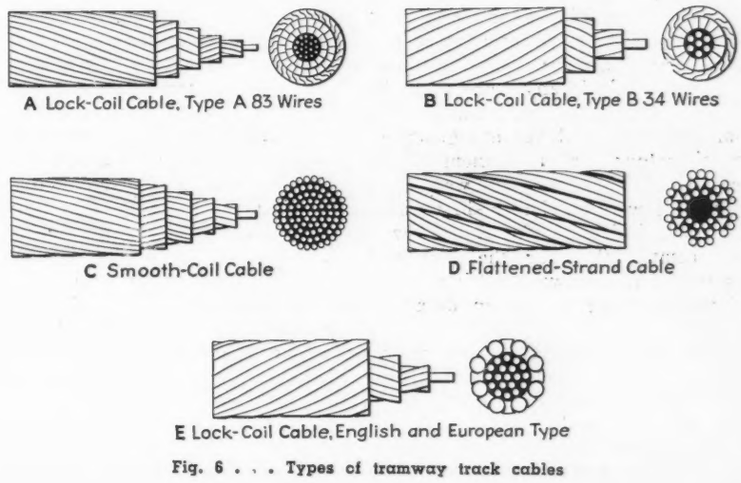
A Lock-Coil Cable, Type A 83 Wires
B Lock-Coil Cable, Type B 34 Wires
C Smooth-Coil Cable
D Flattened-Strand Cable
E Lock-Coil Cable, English and European Type

Fig. 6 . . . Types of tramway track cables

Cost and Weight of Terminal Machinery and Tension Station and Line Equipment

Capacity per Hour	Size Cable, Loaded Side, In.	Size Cable, Empty Side, In.	Size Traction Rope, In.	Couplings per Mile	Capacity Carriers, Cu. Ft.	Spacing of Carriers	Time Interval, Seconds	Number of Carriers per Mile	Number of Supports per Mile	Weight, in Pounds per 100 Feet	Cost per 100 Feet	Terminal Weight, Lb.	Terminal Cost	Tension Station Weight, Lb.	Tension Station Cost	Gage	Number of Men Required to Operate
25	1	⅞	⅝	4	5	300	36	37	20	1,017	$144	26,400	$2,894	7,300	$733	6	3
30	1⅛	⅞	⅝	4	6	300	36	37	22	1,127	155	32,700	3,540	7,800	766	8	3
40	1⅛	⅞	⅝	4	6	225	27	48	22	1,191	172	32,700	3,540	7,800	766	8	4
50	1⅛	⅞	⅝	4	6	180	21.6	59	22	1,256	189	32,700	3,540	7,800	766	8	4
50	1¼	⅞	⅝	5	12	360	43.2	32	22	1,348	184	38,900	4,154	9,100	900	8	4
100	1¼	⅞	⅝	5	12	180	21.6	60	22	1,625	243	38,900	4,154	9,100	900	8	7
100	1⅜	⅞	⅝	6	15	225	27	49	22	1,703	240	38,900	6,087	10,100	1,005	8	7

Table III—Properties and Costs of Tramway Cables

(Prices and discounts furnished by A. Leschen & Sons Rope Co., St. Louis. Mo.)

Class	Service	Construction	Diameter, In.	Cast Steel: Weight Per Foot, Lb.	Cast Steel: Ultimate Strength, Tons	Cast Steel: Price Per Foot	Special Cast Steel: Weight Per Foot, Lb.	Special Cast Steel: Ultimate Strength, Tons	Special Cast Steel: Price Per Foot	Plow Steel: Weight Per Foot, Lb.	Plow Steel: Ultimate Strength, Tons	Plow Steel: Price Per Foot
1	Traction	6 by 7 Lang lay	½	0.38	7.5	$0.09	0.38	8.2	$0.105	0.38	9.0	$0.125
			9/16	0.48	9.4	0.115	0.48	10.3	0.175	0.48	11.3	0.1625
			5/8	0.59	11.5	0.135	0.59	12.6	0.16	0.59	13.8	0.19
		6 by 19 Lang lay	¾	0.90	16.8	0.205	0.90	18.7	0.24	0.90	20.6	0.28
			⅞	1.23	22.8	0.25	1.23	25.4	0.29	1.23	28.0	0.345
			1	1.60	29.5	0.31	1.60	33.0	0.37	1.60	36.5	0.43
2	Track	6 by 8 flattened strand	⅞	1.39	24.0	0.275	1.39	26.5	0.35	[1] 1.39	33.2	0.44
			1	1.80	31.0	0.35	1.80	34.0	0.45	[1] 1.80	43.0	0.58
			1⅛	2.28	39.0	0.45	2.28	43.0	0.54	[1] 2.28	54.0	0.70
			1¼	2.81	48.0	0.54	2.81	52.0	0.68	[1] 2.81	65.0	0.88
			1⅜	3.40	57.0	0.64	3.40	62.0	0.80	[1] 3.40	79.0	1.08
			1½	4.05	67.0	0.75	4.05	74.0	0.93	[1] 4.05	93.0	1.28
3	Track	Smooth coil, 19 wires	⅞	1.55	37.6	0.299	....	....	....	1.55	44.4	0.343
			1	1.98	49.2	0.382	....	....	....	1.98	58.0	0.440
		Smooth coil, 37 wires	1⅛	2.58	60.0	0.462	....	....	....	2.58	70.7	0.508
			1¼	3.10	71.8	0.550	....	....	....	3.10	84.6	0.639
			1⅜	3.79	88.8	0.694	....	....	....	3.79	105.0	0.790
			1½	4.55	108.4	0.953	....	....	....	4.55	127.5	1.045
4	Track	Locked coil, 34- and 83-wire types	⅞	1.92	32.0	0.49	....	....	....	....	....	.....
			1	2.50	42.0	0.64	....	....	....	....	....	.....
			1⅛	3.16	54.0	0.79	....	....	....	....	....	.....
			1¼	3.91	65.0	0.95	....	....	....	....	....	.....
			1⅜	4.73	78.0	1.12	....	....	....	....	....	.....
			1½	5.63	93.0	1.32	....	....	....	....	....	.....

[1] "Hercules".

in Table I. Figs. 3 and 5 show typical designs for steel structures, and Table II shows the cost and weight of material required to build these structures according to the designs.

Foundation Material— Concrete is by far the most satisfactory material for foundation piers. Anchor bolts are more easily placed, and accuracy in alinement and elevation is possible with less effort than with stone masonry. The cost depends almost entirely on the accessibility of the location where it is to be used. In places where cement, gravel, sand, and water must be packed on animals, the cost may be as high as $15 or even more per cubic yard. In more accessible places it may be little if any more than the cost of stone masonry. Timber sills sometimes are used but are generally unsatisfactory on permanent lines. Some serviceable tramways were built with the towers on timber sill foundations, but it is doubtful if the lower cost compensates for the cost and annoyance from towers settling out of alinement owing to uneven decay of the sills.

Equipment— Tramway equipment other than cables comprises driving and control machinery, carriers, saddles, sheaves, and rollers, end and line couplings, attaching and detaching devices, and overhead rail for terminals and intermediate stations. Manufacturers generally do not quote itemized prices on this equipment. It is generally supplied at a gross contract price without regard to the cost of each individual item required for a job. Carstarphen,[4] however, gives the cost and weight of terminal machinery and tension station and line equipment, including carriers, required for tramways ranging in capacity from 25 to 100 tons per hour. These data are shown in tabular form in Part I of Bureau of Mines I. C. 6948, "Aërial Tramways in the Metal-Mining Industry." For convenience they are repeated here.

Cables: General Discussion—Cables must be discussed more comprehensively than any other tramway equipment. They are of primary importance in both the construction and operation of tramways. The wear on cables, and consequently the cost of replacement, is definitely affected by saddles and carriers and also by the arrangement of rollers and sheaves at terminals and towers. In view of this, it is difficult to discuss cables without at least touching on the subject of certain other tramway equipment as well as on general tramway design.

Cable costs for a continuous double-rope tramway of 20 tons' capacity per hour will range from a minimum of about $3,500 per mile for comparatively flat and easy profiles to over $9,500 per mile for profiles requiring long spans and with great differences in elevation between terminals. Roughly speaking, the cable costs for any given profile will increase from $500 to $1,000 per mile for each 10-ton-per-hour increase in capacity. This, however, cannot be taken as a rigid rule for expressing cable costs in relation to capacity. The size of track cables required depends to some extent on the capacity of individual carriers and also on the speed of the traction cable. For instance, Carstarphen specifies 1⅛-in. cables for the loaded side and ⅞-in. for the empty side for tramways of 30-, 40-, and 50-ton-per-hour capacity, using carriers of 600-lb. capacity. With 1,200-lb. carriers, however, the cable size for the 50-ton capacity system is 1¼ in. for the loaded side. With profiles requiring long spans, the size of the track cables is likely to be determined by permissible sag rather than by capacity of carriers.

(To be concluded)

Reprinted from Information Circular 7095, U. S. Bureau of Mines, Washington, D. C.

[4] Carstarphen, F. C.: "Aerial Tramways." Trans. A.S.C.E., Vol. 92, Pp. 875-973.

Tramways in the Metal-Mining Industry

PART III

A NUMBER of types of track cable have been developed by American and European cable manufacturers (Fig. 6. See Part II, May issue, page 113.) A few of the more common types are described briefly here.

Flattened-strand cable of the 6x7-lang-lay construction is recommended by one American cable manufacturer as being superior in durability to all other except the locked-coil types. As with most stranded cables, the wire strands are built around a hemp core. Because of the large proportion of metal wires to the total cross-section area, the tensile strength is about 10 per cent greater than for round-strand cables of the same diameter. The strands of the flattened-strand cable are fitted together in such a manner as to offer maximum resistance to crushing. The outside surface is relatively smooth. Because of this, it wears better than the round-strand varieties. It is made in the same three grades as other strand cables. Prices, unit weights, and tensile strengths for a number of sizes are shown in Table III.—(*E.&M.J.*, May, 1940, page 114).

Smooth-coil cable, sometimes called tramway strand, is made entirely of round wires. It is built up similarly to a single strand of a stranded cable, except that consecutive layers of wires (Fig. 6, C) are twisted in opposite directions. Unlike locked-coil cables, different sizes are made up of different numbers of wires. Thus, in the 1-in. diameter there are 19, in the $1\frac{1}{8}$-in., 37, and in the $1\frac{5}{8}$-in. 61 wires. Because of the fact that it is made up entirely of round wires, the tensile strength is about 15 per cent greater than that of locked-coil cable of the same diameter and grade of material. It is inferior, however, to locked-coil cable in durability and has the objectionable feature that the outside wires untwist when broken.

The type of locked-coil cables used commonly in the United States is made up of a center core of 7 or 19 round wires, one or more layers of wires of square or trapezoidal cross-section, and an outside layer of lock wires. Fig. 6, A and B, shows this type of cable in the 34- and the 83-wire construction. As with smooth-coil cable, consecutive layers of wires are twisted in opposite directions. The locking feature of the lock wires is more positive than in any other type. The cable has a smooth external surface and hence is less damaging to carriage wheels and saddles than any other type. In durability and wearing qualities it is superior to any other type of tramway track cable.

Locked-coil cables and smooth-coil cables are made in cast-steel and plow-steel grades. Prices, unit weights, and tensile strengths are shown in Table III.

The English and European type of locked-coil cable shown in Fig. 6 is little used in the United States. A description of track cables, however, would be incomplete without some mention of it. It was made by several American manufacturers a number of years ago but at present is made principally in England. It is sometimes referred to as half-lock cable because only half of the outside layer of wires are lock wires; the others are round. Because of the greater number of round wires, it has slightly greater tensile strength than the type previously described. It is less durable, however, because of its stiffness and tendency to break from bending stresses.

The amount of service that can be expected from a track cable depends on a number of conditions, some of which are of a controversial nature. The most obvious, although by no means the most important, is the question of cable tension. Cable manufacturers, tramway builders, and tramway engineers disagree as to the tension at which a track cable should be operated to give the best service. Durham[5] suggests a safety factor for locked cables of $3\frac{1}{2}$ or a tension of $28\frac{1}{2}$ per cent of ultimate strength. Recommendations of other authorities, principally cable and tramway manufacturers, range from 25 to probably as much as or more than 35 per cent of ultimate strength. Experienced and successful tramway foremen sometimes operate tramways with the track cables at a lower tension than is generally recommended. It is not suggested that this practice should be followed generally, but the success of certain operators who do follow it and the service they get from the cables are matters that cannot in this discussion be disregarded entirely.

The ratio of cable tension to concentrated load is another matter open to controversy. Considering the lack of agreement on the question of tension only, it is natural that this should be. Stresses due to bending of the cable at the point of loading are obviously proportional to the ratio of the concentrated load to the cable tension. Bending results in elongation or tensile stresses at the outside of the bend and compression or compressive stresses at the inside. Total tensile stresses at the bend are those due to bending plus those due to tension in the cable. The ratio of concentrated load to cable tension should therefore be such that the total tensile stresses at the bend are minimum. The determination of this ratio, however, and the calculation of cable size best suited for any concentrated load, probably is far from a mathematically exact process. The reason for this is that a cable acts very differently in bending than does a solid rod or cylinder. The wires adjust themselves in such manner as to result in only a fraction of the tensile and compressive stresses that occur in a solid medium under the same conditions. Furthermore, cables of different construction have different bending characteristics. If this were not so, it would be pointless and futile to make cables of different degrees of flexibility for different kinds of service. If calculations are to be used at all, they should be interpreted in the light of practical experience under operating conditions.

Carstarphen[6] in his tables of general specifications and costs of tramway equipment shows cable sizes for loads ranging from 500 to 1,500 lb. The table, however, leaves a considerable gap for loads between 600 lb. and 1,200 lb. On the basis of a $1\frac{1}{4}$-in. cable for a load of 1,200 lb., a $1\frac{1}{8}$-in. cable should be satisfactory for loads up to about 900 lb. The data, therefore, extended and modified to include all loads up to 1,600 lb., would be as follows:

	Cable, In.
Loads up to 500.....	1
Loads from 500 to 900 lb....	$1\frac{1}{8}$
Loads from 900 to 1,200 lb..	$1\frac{1}{4}$
Loads from 1,200 to 1,600 lb.	$1\frac{3}{8}$

It is by no means contended that the loads shown here cannot be carried by cables smaller thaan those indicated. There are instances of $1\frac{1}{4}$-in. cables giving good service with four-wheeled carriers of 1,600-lb. capacity. For general purposes, however, it is thought that these data are about as satisfactory as any available and are on the safe side.

The greatest wear on the track

[5] Durham, Edward B.: "Aerial Tramways and Cableways." Mining Engineers' Handbook, by Peele, 2d ed., Vol. 2, Ser. 26. p. 1745.

[6] Carstarphen, F. C., Work cited in footnote 7 (p. 10).

cables is invariably at the towers. The locked-coil types ordinarily can be expected to give a duty of 250,000 to 300,000 tons at the point where abrasive wear and bending are most severe and from 1,500,000 to 3,000,000 tons on the long spans. Flattened-strand and smooth-coil cables, on the other hand, seldom give a service of more than 1,000,000 tons under the most favorable conditions, and generally only from 500,000 to 750,000 tons. Although the first cost is lower, they are less economical ultimately than the locked-coil types.

The amount of wear and breakage at a tower depends on three factors—(1) the deflection angle, (2) the length and design of the saddle, and (3) the type or kind of cable used. These three factors cannot be discussed logically apart from one another, because they are interdependent. It is unsafe, for instance, to say just how small or how large a deflection angle may be, because so much depends on the length of the saddle and the kind of cable used. With short saddles and plow-steel cables it probably is advisable to keep the deflection angles down to 3½ deg. or 4 deg. With 4-ft. rocking saddles and cast-steel cables, angles up to 6 deg. or even larger may be permissible.

The two types of saddles used most generally are the rocking and the stationary. The essential difference is that the stationary type is fixed rigidly to the tower, whereas the rocking type is pivoted on an axis and tilts toward the load as it approaches and leaves the tower. The stationary saddle is now little used except on old tramways. Rocking saddles are available as standard tramway equipment and can be purchased from almost any of the American builders of tramways. Track cables supported by rocking saddles on a three-bent support are shown in Fig. 7.

A third type of saddle is the continuous-grooved rail sometimes used on rail structures as well as on common supporting towers. It differs from the ordinary stationary saddle, first, in that it is longer and requires more than one point of support in fixing it to a tower and, second, in that the cable lies in a deep groove, so that the carriage wheels are not in contact with the cable when the carriage is on the rail; a filler of hardwood or other material in the bottom of the groove eliminates excessive abrasive wear on the cable. It is used occasionally on heavy-duty tramways but seldom on trams of moderate capacity.

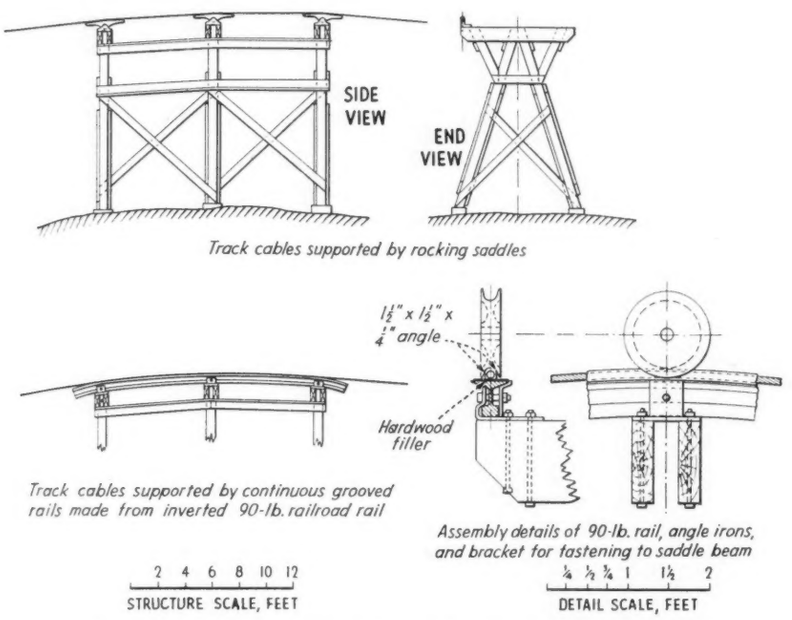
SIDE VIEW
END VIEW
Track cables supported by rocking saddles
1½" x 1½" x ¼" angle
Hardwood filler
Track cables supported by continuous grooved rails made from inverted 90-lb. railroad rail
Assembly details of 90-lb. rail, angle irons, and bracket for fastening to saddle beam
2 4 6 8 10 12
STRUCTURE SCALE, FEET
⅛ ¼ ⅜ ½ 1 1½ 2
DETAIL SCALE, FEET

Fig. 7. Track cable supports, rocking saddle, and continuous grooved rail

Although variations of continuous grooved rails have been used to a limited extent for many years, it is doubtful if they can be obtained as standard equipment. They can be built, however, at any mine that has the ordinary mine-shop facilities. Slight variations in design are possible. The design shown in Fig. 7 was developed by Charles A. Chase, manager of the Shenandoah Dives Mining Company, of Silverton, Colo., for use on the Shenandoah Dives tramway. This line originally was equipped with ordinary standard rocking saddles, which were not entirely satisfactory. Substitution of the grooved rails eliminated much of the excessive tract cable wear at the towers.

Any stranded cable of lang-lay construction and enough flexibility and strength is suitable for traction purposes. The 6 by 7 round-strand construction generally is used in sizes up to ½- or §-in. diameter and the 6 by 19 construction in larger sizes. Special types having small wires in the inside of the strands and large wires on the outside have been developed to give a maximum of flexibility and wearing qualities. Nearly all stranded cables are made in four grades—cast steel, special cast steel, plow steel, and special plow steel. Prices, unit weights, and tensile strengths for various sizes in each grade are given in Table III. The cast-steel grades are the most satisfactory, as they are more flexible and pliable than the plow-steel grade, and hence permit of a better gripping action in attaching the carriers. The plow-steel grade, however, is sometimes used where more than usual tensile strength is required.

Proper care of tramway cables is necessary if long life and maximum service are to be expected. Both track and traction cables should be kept thoroughly lubricated when in use. A lighter and more fluid oil is used on tramway cables than on hoisting cables. It can be applied to the traction cable at the terminals, but a special oiling device must be used for the track cables. One satisfactory arrangement consists of an oil tank fixed to a carriage. The tank is filled partly with oil and partly with compressed air. As the carriage runs over the line the compressed air forces the oil through a small spigot onto the track cable.

Next to lubrication, the most important matter to be considered in connection with traction cables is that of sheaves and rollers. Because wear on the cable is due largely to its passing around sheaves, it is obvious that the fewer and larger the sheaves used, the less will be the wear. Besides the grip or drive sheaves at the control station and the main sheaves at other stations and terminals, a number of idler sheaves or rollers are always necessary to deflect the cable to the proper position for attaching and detaching carriers. The angle of contact with most idler sheaves is very small; hence the amount of wear they cause is negligible. The number and arrangement of sheaves required in attaching a movable tension weight is almost entirely a matter of terminal or control-station design. Perhaps the most satisfactory arrangement is the one whereby the cable passes around one large horizontal sheave mounted on a slide, on which it moves forward and back in taking up the slack. A tail cable reaches from the sheave to the movable tension weight. It may sometimes be necessary for this cable to pass around several sheaves. The wear on it, however, is not great, because of the relatively small amount of movement.

(To be continued)

Excerpted from Information Circular 7095, U. S. Bureau of Mines, Washington, D. C.

Tramways in the Metal-Mining Industry

PART IV

EXCESS TENSION developed in the traction cable when a carrier enters a break-over tower and means of overcoming it by use of overhead rollers are discussed in Bureau of Mines Information Circular 6948. In specific instances where overhead rollers were not used, excess tension in the traction cable and strain on the carriers were great enough to pull the carrier bails out of shape and even break the carriage wheels.

Overhead rollers on rail sections or break-over towers, especially on the loaded side where the tension is greatest, sometimes are placed as close together as space will permit. The object of this practice is to make the angle of contact of the cable with each roller as small as possible and to distribute the weight due to tension in the cable over as many points as possible.

The amount of wear on the traction cable produced by such a battery of rollers is a matter of some controversy. The practice is followed by at least one of the largest cable and tramway manufacturers in the United States. Some tramway operators, on the other hand, believe that less wear will result if the traction cable is supported by large sheaves placed below the carriers instead of by rollers placed just below the grips. Carriers with extra strong bails and carriages are used to take care of the excess tension developed.

Erection and Installation Costs — Erection and installation include the cost of excavating and building foundations, framing and erecting structures, stringing cables, installing machinery, and many other miscellaneous items. These are mostly labor and supervision costs, although other costs, such as trucking, teaming, packing, equipment for stringing cables, and material for erecting temporary buildings, also are involved.

It is in erection and installation that estimates of construction costs are most likely to be in error. Estimates for jobs in isolated regions of rough topography should never be made without first examining each structure location carefully. Material must often be carried by pack animals or even lowered over cliffs by hand to the places where it is to be used. In many places trails, temporary roads, and temporary quarters for workmen must be built. Failure to consider any or all of these items may result in a considerable error in the final estimate. The cost of trail building for the tramway of the Premier Silbak Mines, Ltd., of Premier, British Columbia, was $7,352, or approximately 2 per cent of the total construction cost of $360,000. Temporary quarters cost $5,457, or approximately 1½ per cent of the total. These costs in this particular instance are of relatively little importance, as together they comprise only 3½ per cent of the total. There are instances, however, in which they amount to much more than this.

Stringing and installing cables is a job that requires the services of a specialist and generally some special equipment. Cable installation costs on the Premier tramway were $16,168, or $1,400 per mile; on the Porter (Idaho) tramway of the same company they were $7,377, or $1,475 per mile.

Trucking, teaming, and packing costs depend entirely on accessibility of structure locations. Team hauling for construction of the Premier tramway cost $24,172, or $2,100 per mile. At the Porter (Idaho) tramway, where structure locations were more difficult of access, the cost of handling and transporting equipment was $62,039, or $12,200 per mile.

Fabricated steel costs two to three times as much as unframed timber. According to Staley, the framing and erecting costs of timber for small timber head frames should be around $30 per thousand board feet. This is on a basis of erecting on level ground under reasonably favorable conditions. On steep, rocky hillsides, where working conditions are less favorable, erecting costs are higher.

Underground Construction — The practice of running tramway carriers through adits to underground loading stations was little applied in the metal-mining and other industries until relatively recent years. Even at present, there are only a few isolated examples of important underground installations on the North American Continent. The possibility, however, of substantial savings being made in underground haulage and handling of ore by this means seems to warrant some discussion.

Obviously, the use of aerial tramway carriers for transporting ore through long adits is practical only where surface transportation is by aerial tramway. In such places it may sometimes be found feasible and advantageous to load the carriers from an underground ore pass or transfer station and thus eliminate underground motor haulage and rehandling of ore at the portal. In general, this would be practical at any plant where surface transportation is by tramway and underground transportation through a straight adit. Actually, however, there are only a few isolated instances where the practice mentioned is justified.

Ordinarily, only straight crosscut adits can be equipped for this purpose. Horizontal angles, however, are permissible to about the same extent as for surface lines, provided that the parts of the adit between angles are perfectly straight. Drift adits, on the other hand, could rarely be used, because they are seldom straight for more than a few hundred feet. Character of ground is another feature that must be given careful consideration. No form of underground tramway installation should be considered in ground that does not stand well without timbering. Where motor haulage is used, a certain amount of repair work can be, and often is, done while haulage is in progress. This is possible because of the intermittent nature of motor haulage. It would be impossible, however, where a traction cable and tramway carriers are continually in motion.

An adit for an 8-ft.-gage tramway would have to have a minimum width of about 14 ft. The gage, however, can be drawn down to 6 or even 4 ft. where the cables enter the adit. For the 6-ft. gage, the adit should be about 12 ft. wide, and for the 4-ft. gage, 10 ft. wide. Most tramway carriers of moderate capacity measure about 7 ft. from the top of the carriage wheels to the bottom of the bucket. Allowing for a clearance of 1 ft. below the bucket and a space of 2 ft. above the top of the carriage wheels for placing a timber stull or steel channel on which to fix saddle beams or overhead rail hangers, the height required would be around 10 ft. If there is much cable sag or deflection it would have to be more; therefore, the minimum size of an adit required for tramway transportation would be around 10x10 ft. This compares favorably with adits required for motor haulage, although it is higher than is ordinarily required.

Either track cables or overhead rails can be used for carrier tracks. Construction is simpler and no doubt more economical with cables. Horizontal stulls or steel channels set at the

proper height and at right angles to the length of the tunnel generally are the only members required for attaching saddles, saddle beams, or hangers. If cables are used, the spacing of these stulls or beams need not be closer than 50 to 100 ft.; the minimum spacing would be determined by the permissible sag, which in turn is determined by cable tension and weight of loaded carriers. If overhead rails are used the spacing must be closer—10 ft. or less—and construction slightly more complicated.

On a basis of 50-ft. spacing the cost of 8x10-in. select timber stulls per 1,000 ft. of tunnel would range from $55 to $80, while the cost of 8x2½-in. channels would range from $120 to $180. Since the cost in either instance is only a small percentage of the total cost of all the equipment required, there would be little or no justification for using timber. Steel channels can be placed best by concreting them in a hitch in the proper location near the top of the adit; timber beams, by wedging them in a hitch and blocking the ends from the top. The labor costs should be about the same for each.

Equipping a Tunnel

The total cost of equipping a tunnel for aërial tramway transportation should range from $1,000 to $2,500 per 1,000 ft. or from $5,280 to $13,000 per mile. Compared to this, the cost of equipping for underground motor haulage is negligible. In fact, a tunnel must be equipped for motor haulage while it is under construction. The only saving in construction costs effected by running tramway carriers to an underground loading station is in the elimination of a loading terminal, including bins, at the tunnel portal. Savings in operating costs might be considerable, however, because of the elimination of motor haulage and the rehandling of ore.

The tramway of the San Francisco Mines of Mexico, Ltd., at San Francisco del Oro, Chihuahua, Mexico, is the only important underground installation on which pertinent data are available. This system is described in the *Engineering and Mining Journal* for August, 1936.

The underground portion of this tramway is 931 meters (3,054 ft.) long. It extends from an angle and control station near the tunnel portal to the underground loading station. The tunnel is 3½ meters high by 4 meters wide (11.5 by 13.1 ft.). The track cables, 1½-in. and ⅞-in. locked coil, are supported by rocking saddles suspended from 8-in. channels cemented into the rock at 30-meter (98½-ft.) intervals. Tension in the track cable on the loaded side is maintained at 30 tons by a concrete weight. The carriers have a capacity of 1 metric ton (2204.6 lb.) and a gross weight of 1,200 kg. (2,651 lb.). The center deflection between supports due to the loads is about 0.25 meter (0.82 ft.). The carriers are spaced close enough so that rollers are not required to keep the traction cable from dragging on the bottom of the tunnel.

Types of Tramways, Comparative Costs—Three types of tramways—double-rope continuous, reversible or jig back, and monocable—are described in Information Circular 6948, "Aërial Tramways in the Metal-Mining Industry, Part I." Of these, the double-rope continuous type is the most costly but also the most adaptable to steep grades, rough and varying topography, and long distances. It is the type most generally used in Alaska, Canada, the United States, and Mexico. The reason for this is obvious when it is considered that in these countries aërial-tramway transportation usually is resorted to only in places where the topography is so rough that other methods are impractical.

Reversible or jig-back tramways often are used where physical conditions are favorable. Since there are only two carriers, the carrying capacity decreases as the length increases. A fairly uniform grade is desirable but not essential. Variations in grade can be overcome by using a tail cable that passes around a sheave at the discharge terminal. Cable costs are only slightly if any less than for double-rope continuous systems. Terminals, however, are much less complicated and costly, especially where either terminal is built on a steep hillside. The carriers can be loaded and unloaded without bringing them to a horizontal floor, thus eliminating the necessity of a costly curved-rail assembly, such as must be built at the end of hillside loading terminals for continuous double-rope tramways. Generally, one man does the loading and operates the drive or control machinery. Dumping or unloading is done by an automatic tripping device at the discharge terminal or by a mechanism attached to one of the carrier wheels, which unlatches an end or side gate of the carrier when the direction of travel is reversed. Tramways of this type having capacities from 100 up to 150 tons per hour are in use in the coal-mining and limestone-quarrying industries.

Monocable Systems Rare

Monocable systems are little used in the United States, Canada, or Alaska. Exhaustive inquiry revealed only one important tramway of this type in use in the metal-mining industry on the North American Continent. There may, however, be others. Although the first cost is less, monocable tramways have found little favor with American tramway engineers and manufacturers. The reason for this, as already explained, is that they are less adaptable to rough topography and steep grades than other types. The application and limitations of this type are discussed in Information Circular 6948.

Operating Costs

Operating costs may be considered under the following classifications: power; supervision; labor; repairs; replacements; and depreciation.

Power—A large percentage of tramways are used for transporting ore or concentrates on downgrade only. In such cases a motor is used as a brake and actually puts current back into the line. An induction or a slip-ring motor acts as a generator by running above synchronous speed; slip-ring motors generally are used because they have better speed control. If a synchronous motor is used in conjunction with a slip-ring motor, the speed of the system will be constant regardless of the load, because the synchronous motor will not run at a speed greater than that corresponding to the line frequency. A synchronous motor cannot be used alone, however, because it has no starting torque to overcome line friction in starting when both sides of the line are unloaded or in balance.

If current generated by a tramway can be utilized for other purposes, it is proper to credit the tramway accordingly and thus show a lower overall operating cost. In practice, however, the tramway motor simply puts current back into line to be used for other mine equipment. The power developed by a tramway can be calculated easily if the frictional resistance is known. This, however, cannot be used as a basis of giving a power credit, because of starting, stopping, and short delays. To make a proper credit, the tramway motor should be metered independently. Power cost on tramways that actually require power seldom exceeds 0.2c. per ton-mile; in some instances it is less than 0.1c. per ton-mile.

Supervision—The salary of a tramway foreman generally comprises the entire supervision cost of operating a tramway. The man should be capable of splicing cables, repairing couplings, and supervising repairs. A first-class foreman is often one of the highest-salaried men in a mine organization and may have the same rating as a mine or mill superintendent. Supervision should cost not more than 1c. per ton-mile for trams of moderate length and capacity. Generally, it costs less. It depends to a great extent on the amount of material handled.

(*To be continued*)

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Tramways in the Metal-Mining Industry

PART V

LABOR COSTS generally are the largest single item involved in operating a tramway. The system that requires the least men to operate is the one that will have the lowest per-ton-mile cost. Most tramways at metal-mining plants are used for hauling back freight as well as ore. It is this feature of metal-mine operating that often makes it impracticable, or at least inadvisable, to install automatic or semi-automatic trams at metal-mining plants. Tramway-operating costs at most metal mines in the Western United States range from about 5c. to 10c. per ton-mile. In the coal-mining and construction industries of the Eastern United States, tramming costs of 2c. to 3c per ton-mile are not uncommon, and costs as low as 1c. per ton-mile are reported. The difference can be explained partly by the larger-capacity tramways used in coal mining and construction work, but also many of the tramways in these industries are automatic or semi-automatic and require a minimum of labor in their operation.

The Pardee Dam tramway, length 3.1 miles, capacity 220 tons per hour, consisted of two sections with an intermediate control station. Carriers at terminals and the intermediate control station were handled largely by mechanical means. The carriers remained attached to the traction cable while passing through the discharge terminal and were unloaded while in motion. This tramway could be operated by five men—two at each terminal and one at the intermediate control station as a safety measure. More men than this may have been used; on a basis of five men per shift, however, the labor cost of running the tram would be about ½c. per ton-mile.

The Highland Boy tramway, Bingham Canyon, Utah, capacity 100 tons per hour, is a hand-operated system. The total length is 4 miles. It consists of three sections, each of which is operated by a separate control system. When operating at full capacity, five men are required at the loading station, two at each of the two intermediate control stations, and three at the discharge terminal.

A comparison of these two systems, the one automatic and the other hand-operated, indicates that labor costs per ton-mile for the hand-operated system are approximately four times as great as for the automatic system, due partly to the larger capacity of the automatic system; if, however, it was operated at a reduced capacity equal to that of the hand-operated system, the labor costs would still be only about half that of the hand-operated system. Under actual operating conditions, labor costs for hand-operated systems probably are two to three times those of automatic systems.

Comparatively few automatic trams are in use in the metal-mining industry. One reason for this has already been mentioned—the necessity of hauling back freight. Another reason is that where wet ore is handled in cold climates, freezing would interfere seriously with the free dumping or unloading of the buckets and also with latching and unlatching of a bottom or end door.

The capacity of a hand-operated tramway sometimes is limited to the rate at which carriers can be handled at the terminals. When carriers enter a loading terminal at intervals of 20 seconds or less, it becomes difficult to take care of them by hand methods alone. If they are loaded and dispatched mechanically, however, they can be handled much more rapidly. At the Pardee Dam tramway it was found possible to load and dispatch carriers of 1½-ton capacity in four to five seconds. The normal interval was 24½ seconds and the rated capacity 220 tons per hour. The builders claimed that because of the ease with which carriers could be handled the capacity could be increased greatly by simply adding more buckets.

Two men is the minimum required to run a hand-operated tramway of the continuous double-rope type. For tramways having carrying capacities up to 20 tons per hour, one man must be stationed at the loading terminal and one at the discharge terminal. If the capacity is very much greater than this more men are required, especially at the loading terminal. As the capital expenditures for a tramway of 20 tons per hour capacity are but little more than for one of 8 or 10 tons per hour, it is reasonable to assume that 20 tons per hour is about the low economic limit for tramways of the double-rope continuous type. It is granted that there are small metal-mining plants that do not require a tramway of 20 tons per hour capacity; but in this instance, a little extra bin capacity at the terminals is the only arrangement required to permit the tram to be operated every other day or two to three days per week instead of at full time. For temporary installations where a small increase in capital expenditures is likely to be a controlling factor, a double-rope, continuous tramway of less than 20 tons per hour capacity might be justifiable. For permanent installation, however, it would seem uneconomical to consider a system of this kind of less than 20 tons per hour capacity. Where a small daily tonnage is to be handled and where physical conditions permit, it is better to consider a double-reversible or jig-back tram than a continuous one. The double-reversible tram requires about the same amount of cable as a continuous double-rope tramway, but the terminals cost less and only one man is required to operate it.

An important feature about tramways that greatly affects operating costs is the capacity of the carriers. This often is overlooked when a tramway is designed to deliver a certain daily tonnage. The number of men required at a terminal is determined to a great extent by the time interval between the arrival of buckets or the rate at which the carriers must be handled. For any given hourly tonnage it is obvious that with carriers of 1,200-lb. capacity, the time interval, and hence the number of men required to handle them, is only half what it would be with carriers of 600 lb. capacity. A larger track cable sometimes is required for the larger-capacity carriers. However, where the size of the track cable is determined by the permissible sag rather than by the weight of the concentrated load, there would seem to be little justification for using carriers of less than 1,000-lb. capacity. Even where this is not the case, the saving in cost of carriers would compensate in part at least for the difference in price of the cables.

Table IV—Operating Costs

Tramway	Location	Labor Cost, Cents Per Ton: Per Ton Transported	Labor Cost, Cents Per Ton: Per Ton-Mile	Percent of Total Operating Costs
Shenandoah Dives	Silverton, Colo.	6.2	3.1	60
Premier [a]	Premier, British Columbia	56.1	4.9	63
Peru	Hanover, N. M.	5.4	...	68

[a] Average of five years.

Table V—Major Track Cable Replacement Costs

Tramway	Situation	Capacity per Hour, Tons	Cable, Size in Inches and Type: Loaded Side	Empty Side	Type	Total Tons Trammed When Replaced	Costs per Ton-Mile, Cent: Loaded Side	Empty Side	Total
Sunnyside.....	Silverton, Colo.	40 to 50	1⅜	1⅛	Locked coil cast steel	1,500,000 to 2,500,000	0.22 to 0.35	0.15 to 0.25	(a) 0.37 to 0.60
Silver King.....	Park City, Utah	40	1¼	1	Flattened strand plow steel	Loaded side, 800,000; Empty side, 1,200,000	0.44	0.19	(a) 0.63
Kennecott.....	Kennecott, Alaska	21	1¼	1⅛	Locked coil cast steel	1,500,000 to 2,500,000	0.23 to 0.38	0.19 to 0.32	(b) 0.42 to 0.70

(a) Does not include freight costs.
(b) Includes freight costs.

Table VI—Traction Cable Replacement Costs

Name of Tram	Situation	Capacity, per Hour, Tons	Size Traction Cables, Inches	Kind of Steel	Difference in Elevation of Terminals, Feet	Tons Transported	Cost per Ton-Mile Cent
Premier.....	Premier, B. C..	17	¾	Plow	(a) 1,300	375,000	0.44
Shenandoah Dives.....	Silverton, Colo.	55	⅞	do.	1,500	500,000 to 750,000	0.24 to 0.35
Sunnyside.....	do.	40 to 50	⅞	Special cast	(b) 1,300	750,000 to 1,000,000	0.19 to 0.25

(a) 1 continuous traction cable for 11 miles of tramway.
(b) Tramway in two sections, each operated by a separate traction cable. Vertical distances between ends of lower section about 1,500 ft.; upper section about 800 ft.

Operating costs of automatically operated tramways are affected little by wage rates. Probably the lowest tramming costs in the world have been made on automatically operated systems in the United States, where wages are the highest in the world.

Labor costs of operating tramways at three metal mines in the United States and Canada are shown in Table IV.

Maintenance and Repair—Maintenance and repair costs include repairs on terminals, control stations, and line structures and also minor cable replacements. The stretch in the traction cables must be corrected for occasionally by cutting out a small section and then resplicing the cable. The cost of replacing small sections of track cable in places where the wear is excessive generally is carried as a current operating charge under maintenance and repair.

Minor cable replacements and other repairs that must be made from month to month fall quite naturally into current operating expenses. When a whole traction cable must be replaced, or when all or a large part of a track cable must be discarded and replaced, it is not so obvious how the cost should be distributed. Sometimes it is entered as a deferred charge against future operations, but generally it is charged to current operating expenses as maintenance or replacement.

There are very few available data concerning replacement costs of rolling stock, sheaves, rollers, and other tramway equipment. Replacement of these items generally is charged to current operating expenses as maintenance and repair. Terminal sheaves on the Kennecott tramway, of Kennecott, Alaska, give a duty of about 1,000,000 tons and line sheaves of about 115,000 tons.

Cable Replacements—The wear on traction cables is generally uniform throughout their length. Short sections must be replaced only in case of accidents that damage the cable in one particular place. Generally the cable is used until it is worn to a state that makes it unsafe; it is then discarded and replaced by a new one. The accompanying tables show the performance of track and traction cables at a number of typical tramways and the cost of replacing on a basis of ton-miles.

Depreciation—Actual depreciation charges against a tramway should be based upon the total tonnage transported by it during its lifetime. At metal-mining plants, however, it is seldom possible to predict, even approximately, the tonnage that must be handled ultimately; hence, it is difficult to make a correct depreciation charge against current operations. In practice it is customary to make relatively large depreciation charges against mining equipment during years of prosperity, and thus the total capital expediture of a tramway may be charged off many years before it has served its full usefulness. Under such circumstances, actual depreciation costs seldom appear on company books.

Many tramways serve as surface transportation systems at metal-mining plants from the beginning of operation until the ultimate depletion of ore reserves. Others lose their usefulness many years before the depletion of ore reserves because they are supplanted by other systems, such as long haulage adits. From a study of many successful tramways used at metal-mining plants, the cost appears to range from $30,000 to $65,000 a mile. A great majority of these have transported more than a million tons of ore and some as much as three million tons. On this basis, the actual depreciation costs range from a minimum of 1c. to a maximum of 6.5c. per ton.

Depreciation and amortization costs on the Kennecott tramway of the Kennecott, Alaska, are as follows:

Length of tramway, miles	2.86
Total ore transported, tons	3,505,000
Total cost of tramway	$105,519.76
Cost per mile	36,890.00
Depreciation costs per ton	0.030
Depreciation costs per ton-mile	0.015
Amortization costs, 20 years at 6 per cent, per ton	0.041
Amortization costs, 20 years at 6 per cent, per ton-mile	0.015

Individual Tramways—The following descriptions of tramways are based upon information supplied by mine operators in Alaska, Canada, the United States, and Mexico.

KENNECOTT

The Kennecott Copper Corporation had two tramways for transporting copper ore from its mines to the mill at Kennecott, Alaska. A single discharge terminal is used for both tramways. Since the two systems are of similar construction and have about the same construction and operating costs, only one, the Bonango tramway, will be described here. The total length of this tramway is 2.86 miles. The country through which it passes is rugged and mountainous. Elevation of the loading terminal is 3,609 ft. above that at the discharge terminal. Terminal and line structures are entirely of timber with concrete foundations. The loading terminal is 24 ft. wide by 98 ft. long, with two mill bins of 175 and 325 tons' capacity and a high-grade bin of 250 tons' capacity. Unloading space for freight is approximately 24 by 8 ft. The discharge terminal is approximately 30 ft. wide by 70 ft. long, with 400 tons' bin capacity and 12 by 40 ft. loading space for timber and other mine supplies.

(*To be continued*)

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Tramways in the Metal-Mining Industry

PART VI

LINE structures of Kennecott's Bonango tramway consist of 34 supporting towers of the through type, eight break-over towers or rail sections, including two intermediate tension stations, and one angle or control station. The distance from the loading terminal to the control station is 6,305 ft. and from the control station to the discharge terminal 8,705 ft. The tramway also is used for transporting timber and other supplies to the mine. Passengers may ride only by special permission.

Driving and control machinery comprises a 50-hp. motor geared to an 8-ft. grip sheave at the loading terminal and a 35-hp. motor geared to an 8-ft. grip sheave at the angle or intermediate control station. Total power developed by the tram probably is less than 20 hp.

The track cable is of cast steel and of locked-coil construction; on the loaded side it is 1¼-in. and on the empty side, 1⅛-in. in diameter. The traction cable is ¾ in. in diameter, 6 by 7 lang-lay construction, and of plow steel; it is operated at a speed of 450 ft. per minute. Tension in track and traction cables is maintained by weight boxes.

The carriers, spaced at 450 ft., have a capacity of 6 cu. ft. or 725 lb. On this basis, the carrying capacity of the tramway is approximately 21 tons per hour. The carriers are of the two-wheeled type and are equipped with Weber grips.

The tramway is operated two shifts per day and 363 days per year. Approximately 122,000 tons is handled annually. The labor required to operate the tramway two shifts is as follows:

Loading terminal:	2 men each shift loading and sending out buckets.
Control station:	1 man each shift sending out buckets.
Discharge terminal:	1 man each shift dumping and sending out buckets; 1 lineman, 1 shift only, greasing and inspecting tramway; 1 foreman looking after 2 trams.
Total 2 shifts.....	10

The cost of operating the tramway, including labor, paint, lubrication, repairs, and bucket replacements, has averaged $6.27 per hour. Track cables at the break-over structures, where the wear is greatest, give a duty of about 230,000 tons; on the long spans, up to 3,000,000 tons. The duty of the traction cable is around 230,000 tons, terminal sheaves 1,000,000 tons, and line sheaves 115,000 tons.

The cost of the track cables on the loaded and empty sides is $1.08 per foot and $0.90 per foot, respectively; the traction cable is $0.18 per foot. Assuming a duty of 1,500,000 to 2,500,000 tons for the track cable on long spans and 230,000 tons for the traction cable, replacement costs would be as follows:

	Cents per Ton-Mile
Track cable, loaded side.....	0.23 to 0.38
Track cable, empty side.....	0.19 to 0.32
Total track cables.....	0.42 to 0.70
Traction cable.....	0.83
Total track and traction cables	1.25 to 1.53

Total costs, including operation, liquidation of capital investment, and 20 years' amortization at 6 percent, are as follows:

	Per Ton	*Per Ton-Mile*
Total operating.....	$0.300	$0.109
Tramway cost $105,519.76.. 20 years' amortization at 6 per cent.....	0.030 0.041	0.011 0.015
Total.....	$0.371	$0.135

The Premier Tramway—This tramway is in the vicinity of Stewart, British Columbia, and Hyder, Alaska. It extends from the Premier dock at the head of the Portland Canal in British Columbia to the Premier mine about 9 miles due north. The tramway, however follows a route 11.5 miles long that roughly parallels the Salmon River in Alaska. The lower terminal is at tidewater, the upper one 1,300 ft. above sea level. The lower is built on piling. It has a bin capacity of 1,500 tons.

Three angle stations were required. The angles included between adjacent sections of the tramway are 81 deg. 25 min, 153 deg. 45 min. and 133 deg. 00 min. One continuous traction cable is used for the whole system. It passes around smooth sheaves at the angle stations and the discharge tunnel and around a grip sheave at the loading terminal, where the control machinery is situated. The carriers are run through the angle stations on rails, being automatically ungripped and gripped.

Besides the angle stations already mentioned, there are 163 line structures, consisting of 3 double-anchor stations, 1 double-tension station, 7 combination tension and anchor stations, and 152 towers of the pyramid type. All three angle stations serve as either tension or anchor stations. Track cable sections are anchored at one end and weighted at the other. All structures, including terminals, are of timber.

When the tramway was first built in 1921, ⅞-in. locked-coil track cable was used on the empty side and 1-in. on the loaded side. The traction cable was ⅝-in. cast steel and was run at a speed of 500 f.p.m. with carriers of 8-cu.-ft. or 850-lb. capacity spaced at 1,000-ft. intervals. With this set-up, the carrying capacity was approximately 12.5 tons per hour. Later the mine output was increased, and the tramway capacity had to be increased. The track cables were changed from ⅞ in. to 1 in. on the empty side and from 1 in. to 1¼ in. on the loaded side. The traction cable was changed from ⅝-in. cast steel to ¾-in. plow steel and the speed was increased to 600 f.p.m. Number of buckets was increased from 120 to 140. As a result, the carrying capacity was increased from 12.5 to approximately 17.5 tons per hour.

Driving and control machinery, situated at the loading tunnel, consists of an 8-ft. grip sheave and two 50-hp. motors, one geared for starting and low speeds and the other geared direct by belt for normal running speed. Carriers are of the two-wheeled type and are equipped with Riblet grips.

Complete construction costs, including material, equipment, and installation, are given in Table VII.

During the period from 1925 until about 1930 the tramway was operated at full capacity on a three-shift basis, seven days a week. An average of about 400 tons daily was handled during this entire period. The crew required is shown in Table IX.

Although the carriers were ungripped and gripped automatically at the angle stations, it was considered prudent to have a man stationed at each to insure against accidents. The linemen did all of the routine maintenance work on the towers and tension and anchor stations. Heavy repair work was done by the bull gang under the general superintendent.

All mine supplies, including pipe, rails, lumber, coal, fuel oil, and foodstuffs, were transported over the tramway. Special carriers were used for timber, pipe, rails, and fuel oil.

The first track cables lasted about four years (about 520,000 tons) and the traction cables about three years (about 375,000 tons). Larger cables substituted later lasted longer. Cable wear was greatest where the tramway crossed summits. Replacements made

Table VII—Construction Costs, Premier Tramway

Clearing right-of-way: Labor and supplies			$23,367.95
Upper terminal:			
Excavating and foundations		$2,140.17	
Building and construction		14,839.54	
Equipment	$2,011.16		
Installation cost	775.82		
		2,786.93	
			19,766.69
Lower terminal:			
Building and construction		16,803.42	
Equipment	$4,712.27		
Installation cost	261.07		
		4,973.34	
			21,776.76
Angle stations:			
Excavating and foundations		2,702.67	
Construction		9,929.17	
			12,631.84
Anchorage and tension station:			
Excavating and foundations		5,433.12	
Construction		12,679.75	
Tram equipment		112,056.89	
			130,169.76
General:			
Superintendence		6,183.84	
Traveling expense		2,591.85	
Surveying		6,309.06	
Mess house		10,699.79	
Accounting		2,806.50	
Lumber		21,298.92	
Miscellaneous		2,794.40	
Right-of-way (Government fees)		2,531.90	
Right-of-way		3,110.57	
			58,326.83
Building trails			7,353.58
Stringing cable: Equipment and installation			16,188.94
Towers:			
Excavating and foundations		5,681.96	
Framing and erecting		20,256.38	
			25,938.34
Telephone line:			
Equipment		891.59	
Installation costs		106.08	
			997.67
Mess and bunk houses erected on line			5,457.64
Warehouse			222.75
Steamship freight			8,372.29
Team hauling			24,172.14
Total cost of tramway construction			$354,743.09
Enlargement of tram bin, March, 1923			1,139.41
Installation new tram drive, September, 1924			4,307.03
Total capital expenditure			$360,189.53
Cost per mile (11.5 miles)			31,320.00

Table VIII—Operating Costs, Premier Tramway

Account	Costs per ton 1924	1925	1926	1927	1928
Operating:					
Labor	$0.482	$0.405	$0.372	$0.407	$0.337
Supplies	0.015	0.005	0.004	0.002	0.002
Total operating	$0.497	$0.410	$0.376	$0.409	$0.339
Maintenance of terminals and line structures:					
Labor	$0.028	$0.010	$0.005	$0.019	$0.018
Supplies	0.005	.....	0.003	0.004	0.004
Total	$0.033	$0.010	$0.008	$0.023	$0.022
Maintenance of equipment (including all cable replacements, rolling stock, and telephone line):					
Labor	$0.208	$0.177	$0.086	$0.153	$0.095
Supplies	0.192	0.443	0.125	0.199	0.185
Total	$0.409	$0.620	$0.211	$0.352	$0.280
General and overhead:					
Superintendence	$0.027	$0.026	$0.023	$0.026	$0.024
Power	0.027	0.026	0.017	0.021	0.020
Miscellaneous lubrication, lights, etc.	0.064	0.047	0.044	0.056	0.041
Total	$0.118	$0.099	$0.084	$0.103	$0.085
Grand totals per ton	$1.048	$1.139	$0.679	$0.887	$0.726
Per ton-mile	0.091	0.099	0.059	0.077	0.063

Table IX—Loading Crew, Premier Tramway

	Total
Loading terminal, 2 men per shift	6
Angle stations, 3 men per shift	9
Lower terminal, 2 men per shift	6
Foreman, upper terminal, 1 day shift only	1
Blacksmith, 1 day shift only	1
Blacksmith helper, 1 day shift only	1
Linemen, 3-day shift only	3
Bull gang, 3-day shift only	3
General superintendent, 1 day shift only	1
Total	31

were charged to operating. From 1926 to 1928, inclusive, the cable-replacement costs, not including labor, averaged 0.45 cent per ton-mile for track cable and 0.44 cent per ton-mile for traction cable. Total operating costs from 1924 to 1928, inclusive, are given in Table VIII.

Porter-Idaho

The Porter-Idaho tramway of the Premier Silbak Mine, Ltd., is just south of the Premier tramway and on the opposite side of the Portland Canal. It extends 5 miles to the Porter-Idaho mine. It follows a river course for 3½ miles and then runs up a steep mountainside to the mine. At one place a 4,200-ft. span was necessary to avoid a large area of perpetual snow slides in winter and rock slides in summer. Between this point and the mine, all structures (five in all) are rail sections, tension stations, or anchor stations.

All structures, including terminals, are of steel set on concrete piers. Line structures consist of 37 towers, 5 tension stations, 4 rail sections, and an angle station. Carriers are detached and attached when entering and leaving this station. An intermediate control station is situated approximately two-thirds of the way from the lower terminal to the mine and at an elevation of about 2,000 ft. above the lower terminal and 3,000 ft. below the loading terminal. The lower terminal has 1,000 tons in capacity.

Table X—Construction Costs, Porter-Idaho Tramway

Cleaning right-of-way	$9,124.04
Lower terminal	19,581.22
Upper terminal	13,603.87
Angle station	13,097.25
Intermediate control station	11,142.44
All line structures	33,328.82
Telephone line	2,739.99
Cable and installation	43,743.72
Wiring and lighting	2,761.13
Tramway equipment	51,666.56
Painting all structures	1,455.07
Superintendence and engineering	17,320.12
Construction equipment	6,920.46
Auxiliary tramways: Installation and operation	20,356.86
Handling and transporting supplies	62,039.87
Temporary living quarters	3,355.85
Total cost	$312,237.27
Cost per mile	62,447.45

Diameter of the track cables ranges from 1 in. to 1⅜ in. The larger sizes are used on the longest spans. All cable sections are anchored at both ends. The traction cable is ⅞ in. in diameter, of plow steel, and is operated at a speed of 550 f.p.m. Driving and control machinery consist of a grip sheave at the loading terminal geared to a 60-hp. motor and one at the intermediate control station geared to a 40-hp. motor. Carriers are of 850 lb. capacity and spaced at 800-ft. intervals. The rated capacity of the tramway is 17 tons per hour. Carriers consist of two two-wheeled carriages with a bucket suspended between. Two Riblet grips are provided for each carrier to insure safety on steep slopes of 30 deg. or more.

The tramway was operated for only a short time, and therefore operating costs are not available. Construction costs were given in Table X.

(To be continued)

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Tramways in the Metal-Mining Industry

Part VII

THE Finlayson tramway of Silver King Coalition Mines is near Park City, Utah. It is used for moving crude ore and concentrates from mine and mill to a railroad loading station near Park City and for hauling supplies to the mine and mill. For some years timber and hay were hauled to the mine, but this practice has been discontinued. Total length is 7,047 ft. The country through which it passes is mountainous and quite rugged. The loading terminal is at an altitude of 8,150 ft., the highest point is 8,250 ft., and the discharge terminal is 7,500 ft. above sea level.

Line structures consist of 38 pyramid towers and one tension station, all of steel construction with stone masonry and concrete foundations. The terminals are of timber construction, with bin capacities of 700 tons each.

Track cables are of flattened-strand construction and of plow steel. The one on the loaded side is 1¼ in. and that on the empty side 1 in. in diameter. Tension is maintained by weight boxes suspended at the tension station. The traction cable is ⅞ in. in diameter, 6 by 19 lang-lay construction, and of plow steel; it runs at a speed of 245 f.p.m. Carriers of the two-wheeled type and 6-cu.ft. capacity are spaced at 184-ft. intervals. They are provided with a mechanism for attaching by means of lugs or buttons that are riveted to the track cable. When loaded, they hold 1,000 lb. of lead concentrate or 700 lb. of zinc concentrate. The carrying capacity of the tramway, according to this, is 40 tons of lead concentrates or 28 tons of zinc concentrates per hour. This tramway was built in 1901. The cost of building was approximately as follows: Cost of equipment, $25,000; cost of structural material, $15,890; cost of labor for erection, $29,020; total cost, $64,920; or $48,750 per mile.

The tramway has been operating almost constantly since it was built. From 1901 to 1937 a total of 1,197,830 tons of ore and concentrates, or an average of 35,230 tons per year, was carried. A total of 90,000 tons of coal, or an average of 2,500 tons per year, was carried on the return or empty side. There is no record of the hay and timber carried.

The 1-in. track cable on the empty side is still in use after nearly 38 years of service. The 1¼-in. cable on the loaded side was replaced after 24 years of service. Traction cables last about three years. Cable replacement costs, based on list price less a discount of 5-10-5-5 per cent for track cables and 20-10-5-5 per cent for traction cables, are given in Table XI.

Highland Boy.—The Highland Boy tramway of the National Tunnel & Mines Company is at Bingham Canyon, Utah. It is an unusual installation in that the capacity (100 tons per hour) is larger than that of most tramways used in metal mining. The country through which it passes is rugged and mountainous, but the profile is not extremely difficult. It passes over two summits, one about 6,650 and the other about 8,250 ft. above sea level. The loading terminal is at an elevation of 6,750 ft. and the discharge terminal 6,500 ft. above sea level. The longest span is about 1,100 ft. Several thousand feet of the line ascends slopes of 27 deg.

The tramway is built in three sections with two intermediate control stations. The first section, from the loading terminal to the high summit, is 4,625 ft. long; the second, from the high summit to the second control station, is 3,825 ft. long; and the third, from the second control station to the discharge terminal at the smelter, is 12,525 ft. long. Total length is 20,975 ft., or approximately 4 miles. On the first section the loads are pulled against an adverse grade that averages about 32½ per cent; on the other two sections, the loads travel downhill. The vertical distance from the loading terminal to the first control station is 1,500 ft.; from the first to the second control station, 1,500 ft.; and from the second control station to the discharge terminal, 1,250 ft.

All structures are built of timber. The loading terminal has seven bins of 150 tons' capacity each, and the discharge terminal five bins of 100 tons' capacity each. Line structures comprise 78 supporting towers, 1 double-tension station, 1 double-anchor station, 4 combination anchor and tension stations, and 1 rail structure.

Track cables on both loaded and empty side are 1½ in. in diameter and of locked-coil construction. Tension is maintained at 30 tons by means of weight boxes suspended at the tension stations. The traction cable is 1-1/16 in. in diameter and 6 by 19 lang-lay construction. It is operated at a speed of 600 f.p.m. The carriers, of 1,200 lb. capacity, are of the two-wheel type and weigh 750 lb. unloaded. They are spaced at intervals of 218 ft. The time interval is 21.6 sec.

The tramway was built in 1909. In recent years it has been operating only three days per week at about 50 per cent capacity. In 1928 and 1929, however, it was operated one 7-hour shift per day at a capacity of approximately 95 tons per hour. When operating at full capacity, the operating crew consists of 5 men at the loading terminal, 2 at each control station, 3 at the discharge terminal, 1 foreman, and 1 lineman—a total of 14 men.

The cost of installing the system, not including bins, was $190,000, or $47,500 per mile. When it was operated at full capacity, the operating costs, including all repair, maintenance, and replacement charges, was 28c. per ton, or 7c. per ton-mile.

Table XI—Cable Replacement Costs, Finlayson Tramway

	Diameter, Inches	Duty, Tons	Cost per Ton Mile, Cents
Track cable, loaded side	1¼	800,000	0.44
Track cable, empty side	1	1,200,000	0.19
Traction cable	⅞	125,000	1.70
Total			2.33

Shenandoah Dives.—The tramway of the Shenandoah Dives Mining Company is in San Juan County, Colo., about 3 miles northeast of Silverton. It extends from the company mine in Arastra Basin to the mill in the Animas Valley, a distance of 10,000 ft. The difference in elevation of the terminals in 1,500 ft. The profile of the line is moderately steep but is not difficult.

Terminal structures are of timber with concrete foundations. Line structures comprise 2 tension stations, 1 rail section, and 11 square or box-type towers, all of steel construction. The towers are 16x16 ft. in plan, four of two-bent and seven of three-bent construction. The rail section is 32 ft. long. The tension stations, one 20 and one 32 ft. long, consist of three bents each. All structures are set on concrete foundation piers.

One and one-quarter-inch plow-steel

cables of the half-lock type are used on both the loaded and the empty side. Cable sections are anchored at both ends. From 30,000 to 35,000 lb. tension is applied at the tension stations by means of heavy blocks. The traction cable is ⅞-in., lang-lay, 6 by 19 construction and of plow-steel grade. Rolling stock consists of 45 carriers of 14½ cu.ft. or 1,450-lb. capacity, 7 of 20-cu.ft. or 2,000-lb. capacity, and several timber carriers. All ore carriers are of the revolving type and have four-wheel carriages and Carstarphen grips. Only one timber carrier is required for a load of timber or lumber. The traction cable is run at a speed of 500 f.p.m. with the carriers spaced at 400 ft. Rated capacity is about 55 tons per hour.

The driving and control machinery, situated at the loading terminal, consists of two 6-ft. grip sheaves, one geared to a 50-hp. variable-speed motor and the other to a 50-hp. induction motor. The grip sheaves installed when the tramway was built were not satisfactory and new ones were substituted later. The grips or jaws of the first sheaves were socketed in a continuous groove and depended on gravity to open them for receiving the cable. With the new sheaves, each grip is socketed in a separate pocket with rubber mounting that forces it open when the cable is released. Sheaves of this design are not available as standard tramway equipment. They were designed especially for this tramway by the late D. J. Nevil, of Denver, and were built by the Stearns-Rogers Company, of Denver.

The tramway was designed by F. C. Carstarphen, of Denver, and material and equipment were purchased from various other sources. Construction was begun in the summer of 1929 and completed that December.

A stub tram from the upper terminal is used for transferring lumber, timber, powder, and other supplies from the terminal of the main tramway to the level of the timber yard, shops, and hotel, 100 ft. above the terminal. Carriers loaded with freight are switched from the main tramway to the stub tramway. From the upper end of the stub tram they are run on overhead rails to the timber yard, warehouse, hotel, or wherever the freight is to be delivered.

An advantage of the square type of tower used in this tram is that it increases the number of points of support, thereby diminishing the magnitude of the deflection angles. Each tower had two or three saddles for each cable instead of one, as in the case of most standard types of supporting towers. When the main tramway was first built, it was equipped with standard rocking saddles; those on the loaded sides were replaced by the continuous grooved rails that already have been described in connection with the general discussion of saddles. Inverted 90-lb. railroad rails are used on the structures having three points of support at 8-ft. centers and 12-in. I-beams on those having only two points of support at 16-ft. centers.

The seven 20-cu.ft. buckets are of all-welded construction and were made up at the mine shop from 12- or 15-gage silicon-manganese steel. These buckets decrease the tare weight of the carriers from 780 to 600 lb. and increase the carrying capacity from 1,430 to 2,000 lb.

Eighteen hundred feet of track cable on the loaded side was replaced after three years' use. This showed a small decrease in diameter but was otherwise in good condition. Other replacements consisted of short sections at five points. At the places where the wear is most severe, a life of two years can be anticipated. These replacements have been charged to current operating expenses. Up to December, 1937, two track cables had been replaced. The first one had transported 563,000 and the second one 834,000 tons of ore. Damage caused by accidents made it necessary to replace both cables at an earlier date than otherwise would have been necessary. The replacement costs were $0.0035 per ton-mile for the first cable and $0.0024 per ton-mile for the second.

Five men normally are required to operate the tramway—two at the loading terminal, two at the discharge terminal, and a foreman. When powder, timber, and other supplies are sent to the mine, extra men must be put on as freight handlers. In the costs shown here, it should be noted that credit is given the tramway for freight handling on the main line but none for operating the stub tram, which is used exclusively for freight. After making an adjustment for this, the costs per ton-mile for handling ore only are approximately 5.13c. instead of 6.13c. as shown. The costs broken down for October, 1937, are as shown in Table XII.

The tramway is used for passenger service as well as for freight and ore. Many of the men who work at the mine live in Silverton and make the round trip to the mine each day on the tram. Up to Dec. 1, 1937, 2,000,000 passenger round trips and 8,000,000 passenger miles had been made over the line. About 2,500 tons of freight is taken to the mine each year. Up to March, 1939, approximately 1,800,000 tons of ore had been handled. When operated to capacity without interruption, 1,100 tons of ore can be handled in 20 hours. The cost of the main tram was $126,000, or $63,000 per mile. The stub tram cost $7,500 extra.

Peru—The tramway of the Peru Mining Company at Hanover, N. Mex., is used for carrying crude ore from the mine to a railroad loading station, a distance of 2,225 ft. The country is moderately rough, with a fairly uniform slope from the loading terminal to the discharge terminal, 300 ft. vertically below.

All structures are built of timber. The loading terminal has a bin capacity of 450 tons and the discharge terminal 275 tons. Line structures comprise five supporting towers of the through type. At the end of the loading terminal is a short break-over structure.

The track cable on the loaded side is of smooth-coil construction and 1 in. in diameter; on the empty side, smooth-coil construction and ¾-in. diameter is employed. They are anchored at the loading terminal and weighted at the discharge terminal. Traction cable is of 6 by 19 lang-lay construction, ½ in. in diameter and operated at a speed of 400 f.p.m.

(*To be concluded*)

Reprinted from Information Circular 7095, U. S. Bureau of Mines, Washington, D. C.

Table XII—Operating Cost, Shenandoah Dives Tramway, October, 1937

17,797 tons of ore trammed and milled; 6.4- to 8-hour shifts at 294.6 tons per shift; length, 2 miles (approximate)

Account	Amount	Totals	Per Ton	Per Ton-Mile
Supervision		$271.35	$0.0152	$0.0076
Labor:				
Operators, main tramway	$1,096.40		0.0616	0.0308
Operators, stub tramway	356.56		0.0199	0.0099
Operators, freight handlers	461.96		0.0259	0.0130
Total labor		1,911.92	0.1074	0.0537
Fire insurance		60.56	0.0034	0.0017
Lubrication		8.10	0.0005	0.0002
Miscellaneous items		14.42	0.0008	0.0004
Taxes		28.96	0.0016	0.0008
Tools		39.29	0.0022	0.0011
Maintenance and repairs:				
Buildings	2.80		0.0002	0.0001
Cables	137.98		0.0078	0.0039
Power and electric plant	160.69		0.0090	0.0045
Rolling stock	16.95		0.0009	0.0005
Towers	19.04		0.0011	0.0005
Total maintenance and repairs		337.46	0.0190	0.0095
Gross operation		2,672.06	0.1501	0.0750
Less credit for up freight		490.72	0.0275	0.0137
Net tramway operating		$2,181.34	$0.1226	$0.0613

Tramways in the Metal-Mining Industry

Part VIII

CARRIERS on the tramway of the Peru Mining Company, Hanover, N. Mex., are of the two-wheeled type, of 800-lb. capacity, and spaced at 300 ft. intervals. The carrying capacity of the tramway on this basis is 32 tons per hour. It actually delivers around 420 tons in two 8-hour shifts, or about 26 tons per hour.

Driving and control machinery consists of a 15-hp. motor geared to a 60-in.-diameter smooth sheave located at the loading terminal.

The tramway was built of used equipment, and construction costs are not available. Three men are required to operate, two at the loading terminal and one at the discharge terminal. Labor for operating is contracted for at 5c. per ton. Operating costs for 1937 were as follows: Number of tons transported, 118,600; labor $6,404.00 5.4 c. per ton; maintenance 1,186.00 1.0; replacements 1,768.00 1.5; total 9,358.00 7.9.

Bagdad—The tramway of the Bagdad Copper Company at Bagdad, Ariz., is of the double-reversible or jig-back type. It is one of a comparatively few systems of its type and capacity to be found in the metal-mining industry in the western United States. Most reversible tramways in the industry are of limited length and capacity and will be found principally at small mining plants that do not require a transportation system of great carrying capacity.

The Bagdad tramway can carry about 300 tons in 8 hours, or approximately 38 tons per hour. It is used for transporting copper ore from the mine to the mill, a distance of 780 ft. The country is fairly flat, but there is enough slope for the loads to run by gravity.

Track cables are of locked-coil construction and 1½ in. in diameter. Traction cable is of 6 by 19 regular-lay construction and ½ in. in diameter. Carriers are of 1-ton capacity and dump automatically. The driving mechanism consists of a small mine hoist with a single wood-lagged drum geared to a 15-hp. reversible motor. Two turns of the traction cable around the drum provide enough friction for propelling and controlling the loads.

One man does the loading and operates the hoist. Dumping at the discharge terminal is automatic. Detailed tramming costs are difficult to determine accurately. The tramway operator on night shift operates a crusher also, and the day-shift operator runs the tram only; the night-shift operator runs the tram about two hours and puts in the rest of the shift at the crusher. On this basis, the tramming costs are about 3c. per ton. During December, 1938, and January, February, and March, 1939, 29,198 tons of ore was handled.

San Francisco Mines of Mexico, Ltd.—The tramway system of the San Francisco Mines of Mexico, Ltd., at San Francisco del Oro, Chihuahua, Mexico, has already been mentioned in the chapter on underground construction. The present system is the third that has been in use during the period of active operation of the property, which began prior to 1906. The first tramway, which had a capacity of 300 tons in 24 hours was replaced in 1911 by one having a capacity of 500 tons in 24 hours. This was replaced in 1934 by the present system, which has a rated capacity of 110 metric tons, or approximately 121 short tons per hour. It is actually operated at a capacity of 2,100 metric tons a day.

The complete system comprises two separate tramways or divisions, each of which is built in two sections. It is of more than usual interest because of the underground feature of one section of the San Francisco division and also because of the great flexibility of the system as a whole. Ore from three mines is handled jointly by the two divisions. Each division can be operated independently of the other, and one section of each division can be operated independently of the rest of the system.

San Francisco division has a total length of 7,890 ft. The lower section extends from the Hacienda mill to an angle station near the portal of the La Tinta adit, a distance of 4,820 ft.; the other extends from the angle station into the adit for 3,070 ft. to an underground loading station near the San Francisco shaft. The first section handles the ore from the Clarines tramway, which has its terminal at the La Tinta angle station, as well as that from the underground loading station of the San Francisco mine. Both sections are controlled by one motor situated at the Hacienda Mill terminal and geared to a grip sheave. Power is transmitted from one section to the other through two grip sheaves at the La Tinta angle station and connected by a clutch mechanism so that the first section can be operated independently of the other.

The ground profile from the Hacienda mill to the La Tinta angle station is relatively flat and even. Line structures on this section of the tramway comprise three rail sections, each 22 ft. in length, and seven pyramid towers. The discharge terminal is 210 ft. in length, with 126 ft. of dumping space and 3,000 metric tons' bin capacity. The La Tinta angle station is 182 ft. in length. All structures are of steel on concrete foundation piers. Construction practices used on the underground section of the tramway are described in the chapter on underground construction. Old worked-out stopes were utilized for underground loading bins. Ore is loaded from these bins directly into the tramway carriers through six loading chutes. Total capacity of the bins is 7,000 metric tons. Total length of the loading station is approximately 286 ft.

Seven-eighths-inch locked-coil cable is used on the empty side and 1½-in. on the loaded side. Tension on the loaded side is maintained at 30 tons and on the empty side at 12 tons by concrete blocks suspended at the La Tinta angle station and the Hacienda terminal. The traction cable is of 6 by 7 lang-lay construction ⅝ in. in diameter and of plow-steel grade. It is operated at a speed of 500 f.p.m. The carriers, of the two-wheeled type, have a capacity of 1 metric ton of sulphide ore or 800 kg. (1,780 lb.) of oxide ore. The average carrying capacity of the tramway when handling oxide and sulphide ores is around 110 metric tons (123 short tons) per hour.

About 190 tons of steel was used in the construction of this tramway. Track and traction cables, tension-station and anchor-station equipment, terminal machinery, line couplings, and saddles were furnished by contract by the American Steel & Wire Company at a cost of $52,000. Cost of structural material, including steel, concrete, and timber, was $30,000. Installation costs, including labor, supervision, engineering, and related factors, were $34,000, making a total of $116,000, or approximately $77,333 per mile.

The Clarines tramway has a total length of 16,460 ft. (3.12 miles). One section extends from the discharge terminal at the La Tinta angle station to the La Mesa loading station, a distance of 8,021 ft., the other from the Le Mesa loading station to the loading terminal at the Clarines Mine, a distance of 8,304 ft. Ore from the El Toro mine is loaded at the La Mesa loading station. Both sections are driven or controlled by one 40-hp.

motor at the La Mesa loading station geared to a grip sheave. This grip sheave is connected by a clutch mechanism to another, which operates the second section. The arrangement is similar to that at the La Tinta angle station of the San Francisco division, except that the motor and both grip sheaves are at one station, whereas at the San Francisco tramway two grip sheaves are at one station while the motor and one grip sheave are at another. Carriers from the Clarines mine pass directly through the La Mesa loading station on their way to the discharge terminal at the La Tinta angle station of the San Francisco tramway. When handling ore from the La Mesa bins, the second or Clarines section can be unclutched and the first section operated independently.

The ground profile of this division is more difficult than that of the San Francisco. Terminals are at about the same elevation, 6,700 ft. above sea level; the highest intermediate point is 7,700 ft above sea level.

Terminals and all intermediate structures are of steel with concrete foundations. The Clarines loading terminal has a bin capacity of 1,200 tons, the La Mesa loading station 300 tons, and the La Tinta discharge terminal 1,200 tons. Track cable on the loaded side is 1¼-in. locked-coil construction, on the empty side ⅞-in. locked-coil construction. The traction cable is of 6 by 7 lang-lay construction, ¾ in. in diameter, and of plow steel. It is operated at a speed of 500 f.p.m. The carriers, of the two-wheeled type, have a capacity of 500 kg. (1,170 lb.) of sulphide ore and a little less of oxide ore. The carrying capacity of the tramway is 50 metric tons of sulphide ore per hour, or 40 tons of oxide ore per hour.

Both the San Francisco and the Clarines tramways are semi-automatic in operation. The overhead rails at the terminals are set at enough grade so that the carriers run by gravity from the point at which they are detached from the traction cables to where they are loaded from hand-operated chutes. From the loading chutes they run by gravity to automatic attachers, where they are held by an operator until the proper time for dispatching. Dumping at the discharge terminals is done automatically by a tripping device that can be moved to any point where dumping is desired. In passing through angle and intermediate control stations, the carriers are detached from one section and attached to the other entirely by mechanical means.

Traction cables are good for about 1,000,000 metric tons. After a cable has been used for about 600,000 tons on the heavy-duty or surface section of the San Francisco tramway, it is changed to the underground section, where it gives an additional service of 400,000 metric tons. Track cables on the San Francisco tramway are still good after five years of use, during which time approximately 600,000 metric tons a year, or a total of 3,000,000 metric tons of ore, was transported.

Operating crews consist of seven men per shift on the Clarines tramway and nine on the San Francisco. Besides the regular operating crews, there is a crew of nine men who do repair, maintenance, and cable-replacement work. The total average crew and the wage rates (Mexican currency) for the year ended September, 1938 is as shown in Table XIII.

Conclusion

Aërial tramways are probably the most highly specialized means of transportation known to the mining industry. They were developed primarily for use in countries of rough topography, where other methods were impractical and in many cases impossible. Their dependability and efficiency for this purpose were proved so effectively in the early days of their development that they eventually came into prominence in the coal-mining, quarrying, and construction industries in direct competition with nearly every other known means of transportation.

Construction costs in mountainous countries, as indicated in Table XV range from $30,000 to $65,000 per mile for systems of moderate capacity. For systems having capacities of 100 tons per hour, or more, the costs are as high as $77,000 per mile. Operating costs for systems of moderate length and capacity, such as are ordinarily used in the metal-mining industry in the United States, Canada, and Alaska, range from 5 to 10c. per ton mile. Direct operating costs for the 12-mile tramway of the American Metal Company at Pecos, N. M., range from 2.1 to 3.7c. per ton-mile. In Mexico, operating costs, including depreciation, run as low as 3.3c. per ton-mile on systems of moderate length. This is possible because of semiautomatic equipment, large tonnage, and low labor costs. Apparently, lower costs at metal-mining plants in the United States and Canada will be possible only by the use of more automatic or semiautomatic equipment. This is possible at plants where only ore is handled but not where much back freight must be carried as well.

Comparisons of transportation costs by aerial tramways with other methods are difficult and sometimes meaningless. So many factors must be taken into account that it is often impossible to calculate figures that show a true comparison. Haulage costs by truck are greatly affected by the methods of loading and unloading, and with aerial tramways by the amount of back freight that must be handled. At the Premier mine in British Columbia, where a relatively large amount of back freight was handled by the tramway, the cost ranged from 5.8 to 9.9c. per ton-mile.

(To be concluded)

Reprinted from Information Circular 7095, U. S. Bureau of Mines, Washington, D. C.

Table XIII—Tramway Crews and Wage Rates, San Francisco Mines of Mexico

Average tramway crew during fiscal year ended Sept. 30, 1938

	Men	Pesos	
Clarines tramway			
Clarines loading station:			
1 dispatcher at 5 pesos per shift	3	15.00	
1 loader at 4.5 pesos per shift	3	13.50	
1 operator at 4.5 pesos per shift	3	13.50	
			42.00
Intermediate loading station:			
1 motor operator at 5 pesos per shift	3	15.00	
1 helper at 4.5 pesos per shift	3	13.50	
			28.50
Discharge terminal:			
1 dispatcher at 5 pesos per shift	3	15.00	
1 operator at 4.5 pesos per shift	3	13.50	
			28.50
Repair crew:			
1 repair foreman	1	6.50	
1 repair helper	1	4.50	
1 oiler	1	4.50	15.50
Total	24		114.50
San Francisco tramway			
Underground loading station:			
1 dispatcher at 5 pesos per shift	3	15.00	
4 operators at 4.5 pesos each	12	54.00	
			69.00
Angle station:			
1 operator at 4.5 pesos per shift	3	13.50	
			13.50
Discharge terminal:			
1 motor operator at 5 pesos per shift	3	15.00	
1 dispatcher at 5 pesos per shift	3	15.00	
1 operator at 4.5 pesos per shift	3	13.50	
			43.50
Repair crew:			
1 repair foreman	1	9.50	
1 cable repairman	1	9.75	
1 cabo menor	1	6.50	
1 oiler	1	4.50	
1 repairman	1	5.00	
1 repairman	1	4.50	39.75
Total	33		165.75
General:			
1 truck driver	1	6.00	6.00
Total per day	58		286.25

Differential Grinding of Alabama Iron Ores for Gravity Concentration

RECENT WORK on beneficiation of the Alabama red iron ores and ferruginous sandstones has brought out interesting facts on particle-size reduction that are a valuable supplement to what is already known. The work was done by the Southern Experiment Station of the Bureau of Mines in cooperation with the University of Alabama, University, Ala., on two samples from the Birmingham district. One was an oolitic red iron ore containing about 35 per cent iron; the other was a ferruginous sandstone containing about 25 per cent iron, particularly attractive because of its low phosphorus content. In both samples rounded quartz (sand) grains were embedded in an oolitic, "onion-skin" matrix of hematite. The hematite carries varying amounts of clay, which limits the grade of concentrate that can be made. The clayey hematite is soft, so that the rock crumbles readily under pressure. The sand grains shell out like corn, and without much exaggeration the mill used for differential grinding might be called a "sheller."

Nature of Sand Grains—The outstanding fact is that the particle size of the sand in the two samples is different. Table I shows that the predominating size of the sand in the red ore is 35-mesh, whereas the predominating size in sandstone is 100-mesh. About half (46.7 per cent) of the ferruginous sandstone is rounded quartz sand.

Table I.—Screen Test on Sand from Iron Ores

Mesh	Red Iron Ore, Weight, %	Ferruginous Sandstone, Weight, %
− 10+ 14	1.1	
− 14+ 20	7.7	Trace
− 20+ 28	17.3	Trace
− 28+ 35	23.5	0.1
− 35+ 48	21.5	1.3
− 48+ 65	12.5	23.9
− 65+100	9.6	50.1
−100+150	4.7	16.7
−150+200	2.1	3.4
−200	....	4.5
	100.0	100.0
Sands in ore, %	20.3	46.7
Fe in ore, %	35.9	28.5
CaO in ore, %	10.2	0.06

In the sizing tests of the sand the ores in lump form were treated with hydrochloric acid to dissolve the hematite, the solution was removed, and the residue was screened in neutral water, a rubber muller being used to disintegrate the particles of clay. A fine, clean sand was thus obtained as a final residue. Examination of the shape characteristics of the particles in these residues, size by size, under a comparator microscope indicates that the sands in the two ores may not have the same origin, but this question has not been answered. However, all grains were predominantly rounded—an important characteristic in beneficiation by gravity methods. If they were angular and flaky after the manner of crushed quartz, satisfactory gravity concentration of these ores would be more difficult; in fact, it would be impossible. Being rounded, they roll and race freely to the side of the table in table concentrations and settle freely in a bowl classifier, where a slime of concentrate grade is removed over the top of the bowl.

The hematite that is cemented to the sand grains and persists as an iron stain is beyond recovery by any known physical separation. Hence, such a loss would appear to be proportional to the amount of surface of the sand. Assuming that this theory is correct, a unit weight of the ferruginous sandstone would have about five times as much sand-hematite interface as an equal amount of red iron ore (Table I). If the assumption is carried further to consider percentage recovery, it may be shown that for each unit of iron in the ferruginous sandstone there is seven times as much sand surface as in the red ore. On this basis the red ore would be expected to give a higher recovery. However, this assumption does not hold true by tests—the ferruginous sandstone yields as good a recovery. Hence, the conclusion is reached that the cementation is not so severe in the ferruginous sandstones. They yield a lower-grade tailing in spite of the preponderance of sand surface; the "shelling" of the ferruginous sandstone releases cleaner quartz grains than the red iron ore.

Hematite and Differential Grinding—The sand grains have the customary hardness of quartz, but the cementing hematite is relatively soft. Hence, there is a difference in resistance to particle-size reduction, and this difference must be utilized if gravity concentration is to be applied. Differential grinding—that is, reduction of the soft particles while the hard particles are left in their natural discrete state—was therefore practiced. This unique method of grinding is the essence of the success achieved in developing a simple flowsheet for gravity concentration. The remarkable part is that the hematite is greatly reduced in size and liberated, but the sand is not attacked. In fact, from a practical standpoint the hematite approaches a colloidal state. On the other hand the sand has a limit of fineness. Table I shows that the sand finer than 200 mesh may be regarded as absent. Hence, when differential grinding is properly applied, much of the hematite may be taken off by ordinary desliming methods.

If all the hematite yielded a slime in differential grinding, the recovery could be made to approach closely to 100 per cent, but its nature does not permit it. Part of the hematite is hard, high in grade, and resistant, and for maximum recoveries gravity concentration is necessary. Furthermore, in the red ores oolites high in lime induce a loss by their resistance to treatment. A red ore with a low lime content is expected to be most benefited by differential grinding.

Differential Grinding of Red Iron Ore—The red iron ore may be reduced to ⅜ in. by any convenient method. About equal amounts are retained on or pass through an 8-mesh screen; furthermore, the iron content is not segregated appreciably in the two sizes, but only at sizes finer than that of the predominating amount of sand.

Further reduction of the ore must be made by a well-designed method that will not crush the quartz particles. However, since concentration at 8-mesh is anticipated, one-half has already gone through the first step in preparation by the reduction through ⅜ in. This may be termed the "natural" minus 8-mesh size to distinguish it from the coarser portion. Some of the characteristics of this material are shown in Table II.

Table II.—"Natural" Minus 8-Mesh Product From the ⅜-in. Grind

Mesh	Weight, %	Assay, % Fe		Distribution, % Fe	
− 8+100	77.2	32.1		70.5	
+100+150	3.5	40.3		4.0	
+150+200	2.2	42.0	45.2	2.6	29.5
+200	17.1	47.0		22.9	
	100.0	35.0		100.0	

Table II shows that a severe desliming may be expected to take off 29.5 per cent of the iron in a slime 45.2 per cent iron, but if the desliming is more precise and at 200 mesh, 47 per cent iron may be expected. The table concentration of the coarser sizes has been previously described.

Means of reducing the ⅜-in. to 8-mesh size will now be considered.

Only two methods will be mentioned here—roll grinding and differential rod milling. The results of laboratory tests are shown in Table III.

Although the roll grinding was performed in closed circuit and with great care to avoid reducing the sand particles, it hardly seems acceptable when compared with the rod milling, which yielded 35 per cent of the iron in a slime 47.9 per cent in iron. Hence, only the rod milling will be discussed. This was done in a laboratory mill 19 in. in diameter and 36 in. long, with rods 1½ in. in diameter. The discharge opening was 8 in. in diameter. A rod volume of only 13 per cent (300 lb.) instead of the customary 45 per cent, was selected.

Here the small rod volume leaves space for a great amount of ore, some of the particles of which will be subjected to attrition by tumbling upon each other. The speed of the mill must not be high enough to cataract the rods against the breast of the mill, as such cataracting would crush some of the quartz grains.

The "natural" fines shown in Table II, although already through 8 mesh, needed some differential grinding to remove more of the hematite veneer from the quartz grains. Consequently the minus ⅜-in. product would not be screened on 8 mesh as was done to dissect the problem but would be sent to the rod mill. Thus screening to ⅜-in. size at the head of the rod mill completes the preparation.

Differential Grinding of the Ferruginous Sandstone—Except for the size of the screens at the discharge of the mill, the flowsheets for the two ores will be identical; both ores will be reduced to ⅜-in. for the feed to the rod mill, and the table middlings will be returned to the rod mill for treatment. The only difference lies in the mesh of the screens at the end of the rod mill. As already stated the red iron ore requires an 8-mesh screen. Similarly, the ferruginous sandstone requires a 30- by 30-mesh screen. The finest screens permissible should be used to reduce the last clusters of fine sand still cemented by hematite. Yet the screens must be coarse enough to permit coarsest sand grains to pass.

Doubtless the first impulse of the operator will be one of alarm about screening an iron ore through 30 mesh, and hence it must be explained that the product is unlike the discharge of ordinary grinding machines. The 20- to 28-mesh size is only 1.0 per cent of the whole. Furthermore, the sharp and angular grains presented in ordinary ball milling are absent.

The feed was through ⅜-in. and the circulating load was 250 per cent. The small amount at the critical size (30 mesh) facilitates screening. It is believed that the customary classifier cannot compete where the screening is so simple. Each ore yields a concentrate approaching 50 per cent iron, and the recoveries will be between 80 and 90 per cent.

Excerpted from Report of Investigation 3523 of the United States Bureau of Mines, Washington, D. C., by Will H. Coghill and Philip H. Delano.

Table III.—Reduction of Red Iron Ores, Minus ⅜-In. Plus 8 Mesh, to 8 Mesh by Rolls and by Rod Mill

	Rolls			Differential Rod Milling		
Mesh	Weight, %	Assay, % Fe	Distribution, % Fe	Weight %	Assay, % Fe	Distribution, % Fe
− 8+100	86.0	34.6	82.5	73.3	32.3	65.0
−100+150	2.8	42.6	3.3	2.6	41.3	3.3
−150+200	1.7	43.3 45.0	1.9 17.3	2.3	42.6 47.9	2.7 35.0
−200	9.5	46.2	12.2	21.5	49.3	29.0
	100.0	36.0	100.0	100.0	36.5	100.0

Tramways in the Metal Mining Industry—IX

Gardner shows trucking costs for Arizona, California, Montana, and Nevada. Costs for distances of 1 to 20 miles and for jobs that require no shoveling range from 5 to 30c. per ton-mile. Aërial-tramway costs for distances of 1 to 12 miles, including systems where back freight is handled, range from 2.1 to 13.5c. per ton-mile. In places where a direct comparison is possible, tramways show about the same and sometimes a greater advantage over trucks. For instance, at the Peru mine in Hanover, N. M., tramway transportation costs from the mine to the railroad loading station are around 8c. per ton; the lowest bid made by a trucking contractor was 15c. per ton.

At its present stage of development, the aërial tramway is a rigid system, suitable only for transportation between fixed points. It is possible that this is one of the reasons why tramways have fallen into disfavor with metal-mine operations in recent years. Modern industry requires in its transportation systems a flexibility that has not yet been developed in aërial tramways. Another reason for the lack of interest in this means of transportation by metal-mine operators is the present tendency toward small operating units where there is not a sufficient ore reserve to justify the capital expenditure necessary for an elaborate and expensive transportation system.

Greater flexibility might greatly enhance the use of aërial tramways in certain metal-mining fields such as small open-pit mining. Here, the reversible tram with a movable loading terminal might be used to advantage, provided large boulders are not too much of a problem. Whether or not a movable loading terminal is practical is open to some doubt, but movable towers used in connection with slackline systems would indicate that they are. Tramways of moderate capacity that could be dismantled easily and at a low cost and reinstalled at other properties, might find favor with metal-mining companies that operate mines in different places. The success of such development would seem to depend primarily on more standardized construction practices, and also on a more thorough knowledge and understanding among mine operators and mining engineers of the principle and practices involved.

The End

The following paragraphs, together with Table XIV, were accidentally omitted from the text describing variout tramway installations in the United States, Canada, and Mexico, which was made to terminate on page 114D of the November issue.

Operating costs of the Clarines tramway are slightly greater than those for the San Francisco. The costs shown in Table XIV are for a total of 570,710 metric tons of ore hauled over the surface section of the San Francisco tramway. Of this, 43,190 metric tons was from the El Toro mine and 128,580 metric tons from the Clarines mine. All costs are in U. S. currency.

Replacements including 10,000 ft. of ⅝-in. traction rope, and major repair items requisitioned during the above period amounted to $3,150,000.

Table XIV—Aerial Tramway Cost per Metric Ton, 12 Months Ended Sept. 30, 1938

	Clarines	San Francisco	La Mesa	Over-all Total
Distance in miles	4.00	1.5	2.43	(a) 2.13
Metric tons hauled	128,580	389,940	43,190	570,710
Labor and bosses	$0.1100	$0.0414	$0.0851	$0.0602
Supplies	0.0252	0.0094	0.0201	0.0138
Power	0.0033	0.0011	0.0023	0.0017
Shops and miscellaneous	0.0140	0.0056	0.0125	0.0078
Total	0.1525	0.0575	0.1200	0.0835
Per metric ton-mile	0.03815	0.0384	0.0493	0.0392
Per ton-mile	0.0340	0.0342	0.0430	0.0350

(a) Average.

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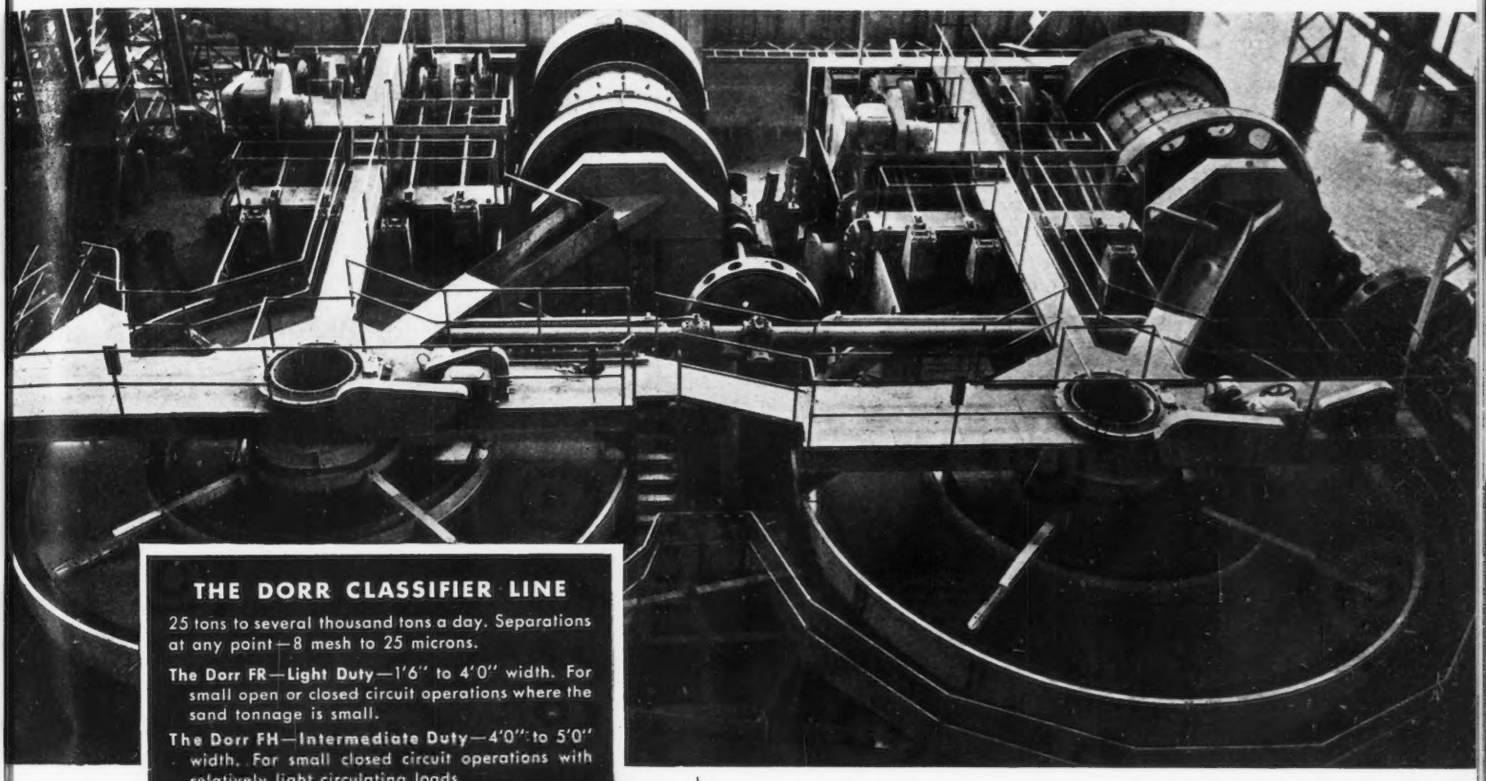

Fine separations—a pair of Dorr Bowl Classifiers in closed circuit with ball mills, grinding to 96 percent minus 200 mesh.

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25 tons to several thousand tons a day. Separations at any point—8 mesh to 25 microns.

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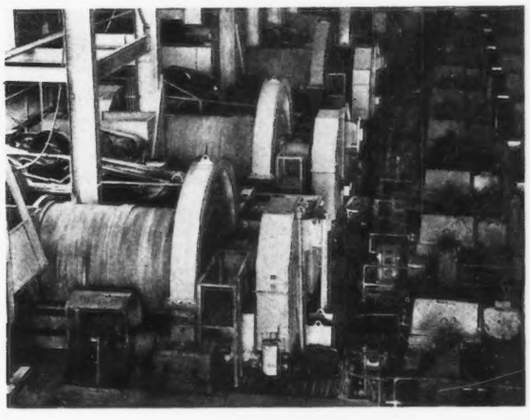
The Dorr FH—Intermediate Duty—4'0" to 5'0" width. For small closed circuit operations with relatively light circulating loads.

The Dorr F—Normal Duty—6'0" to 16'0" width. For the average or normal closed circuit operation—the general run-of-mill classification job.

The Dorr FX—Heavy Duty—5'0" to 16'0" width. For the heavy and really tough closed circuit operation, where the circulating load is high, the sands are heavy and the service is exacting.

The Dorr Bowl—Bowls up to 30 ft. diameter, available with all of the above types for extremely fine separations or relatively great overflow capacities compared with sand raking capacities.

Coarse separations—five Dorr FX Classifiers in closed circuit with ball mills grinding to 14 mesh.



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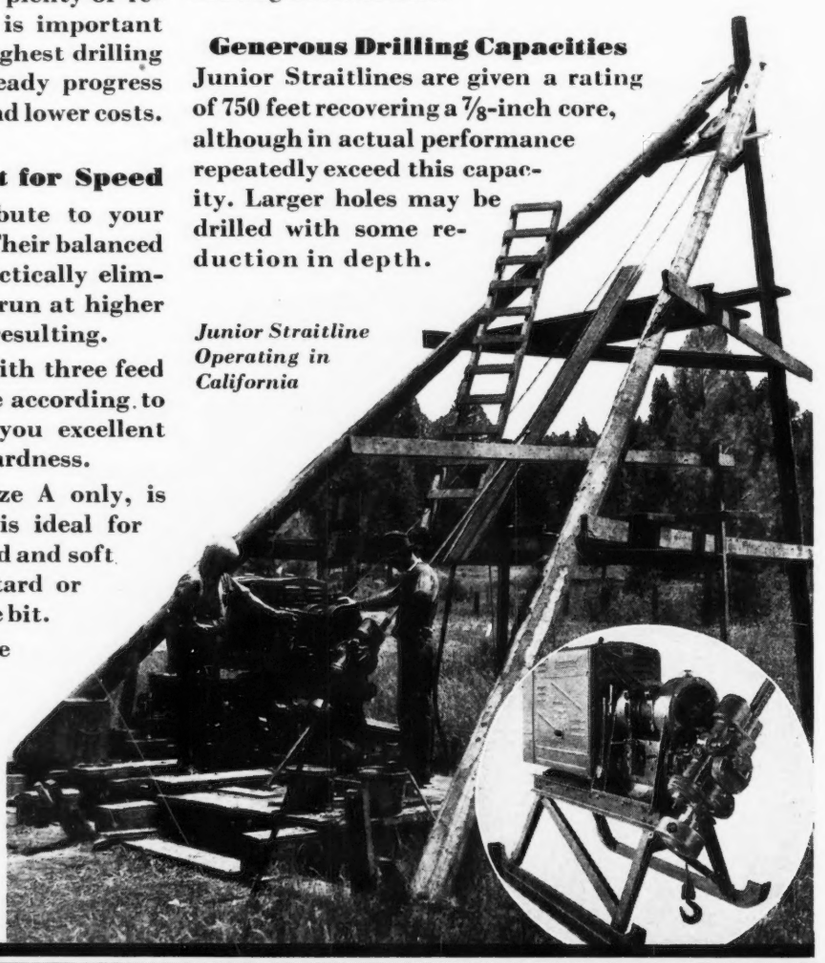
Junior Straitlines are given a rating of 750 feet recovering a 7/8-inch core, although in actual performance repeatedly exceed this capacity. Larger holes may be drilled with some reduction in depth.



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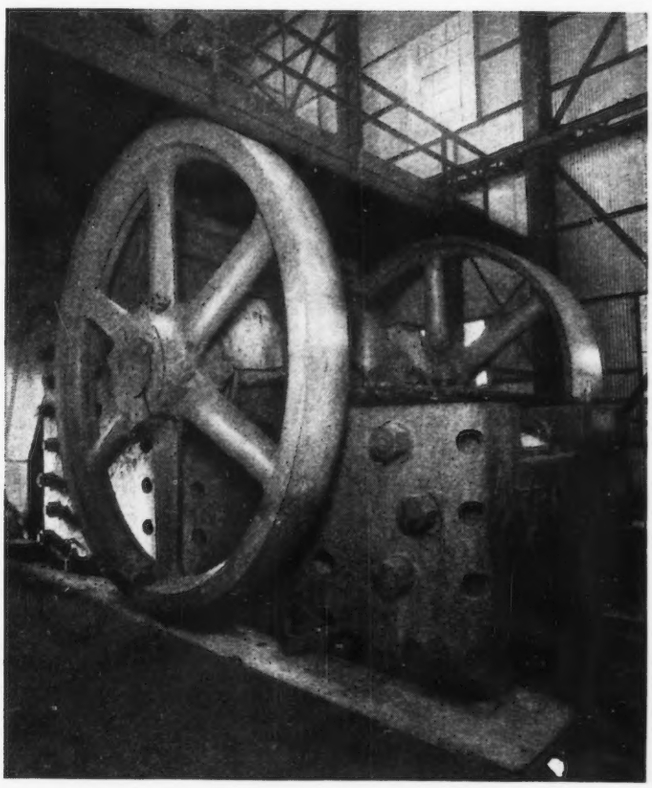

One great gold mining company has four 28" x 36" Traylor Bulldog Jaw Crushers in different levels of its mine; another, three of size 36" x 48"; a third, an iron mine, two 36" x 48" and two 10" x 72"; a fourth (a great steel company) one 36" x 48", one 36" x 72", two 48" x 60" and one 56" x 72". And so we could go on—and if we were to give the names of these users, the list would be a veritable "Who's Who" in mining in the United States and Canada, in Mexico, South America, Europe, Africa and the Orient.

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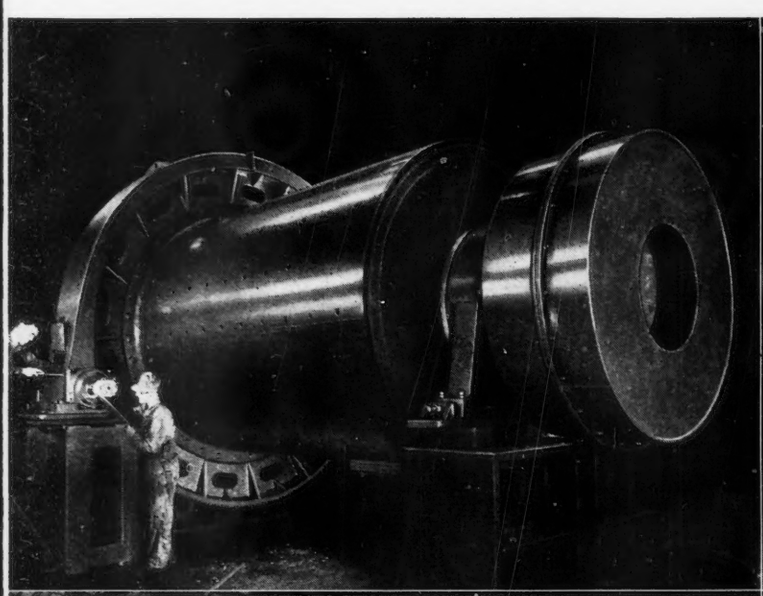

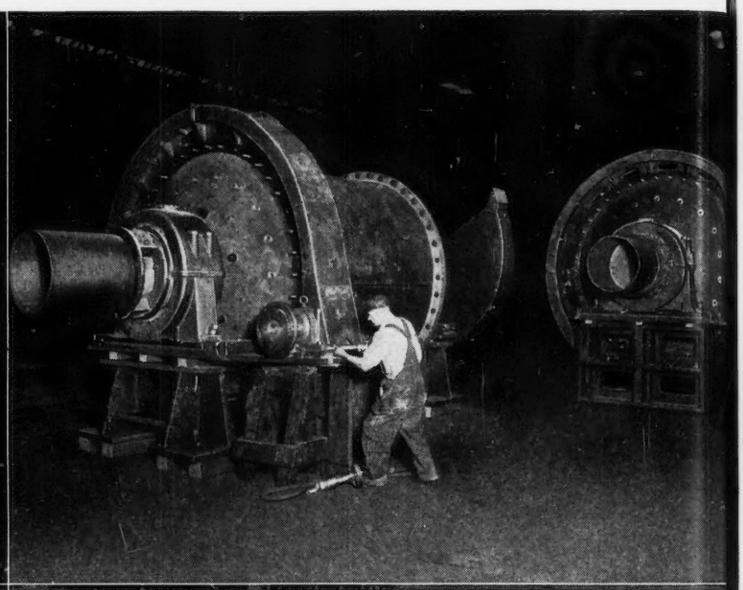

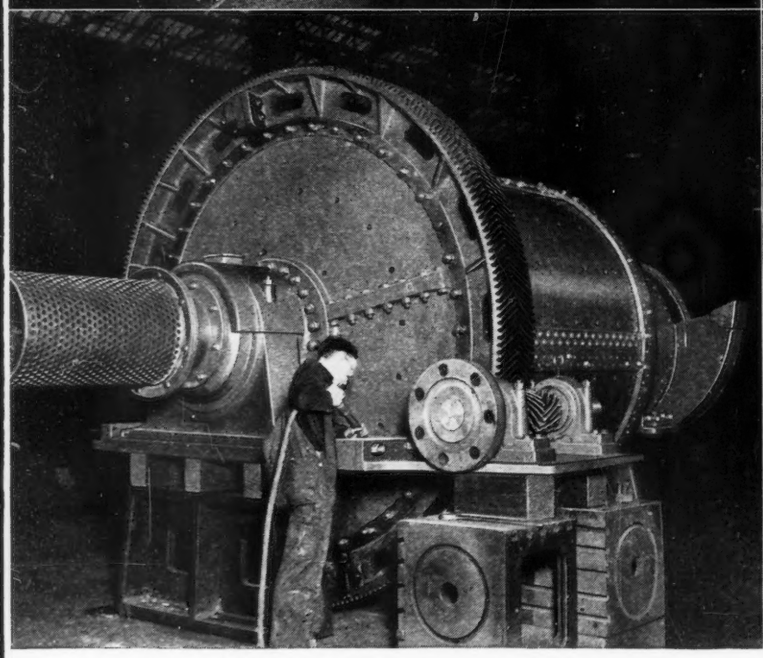

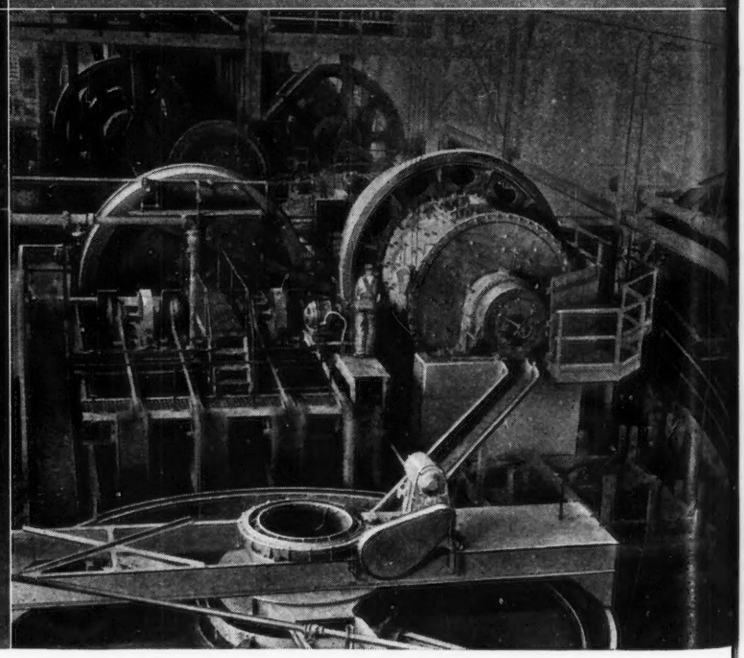

A FEW OF THE 50 VARIETIES OF ALLIS-Chalmers cylindrical mills that deliver better grinding at lower cost in 3445 installations on every type of ore all over the world. TOP: (Left) 8′ x 11′ all-welded differential grinding slug mill. (Right) Two 8′ x 8′ "intermediate-level" ball mills. BOTTOM; (Left) Sectionalized for airplane transportation — a 9′ x 8′ ball mill for a gold cyanide plant in Nicaragua. (Right) Fed by a 15 ft sandwheel, the 9′6″ x 8′8″ wet grinding Convel Ball Mills operate in closed circuit with classifiers.

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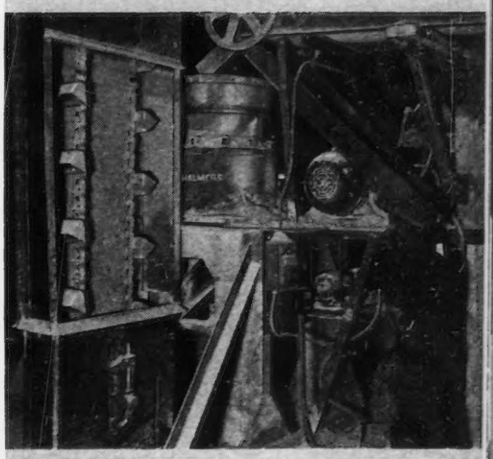

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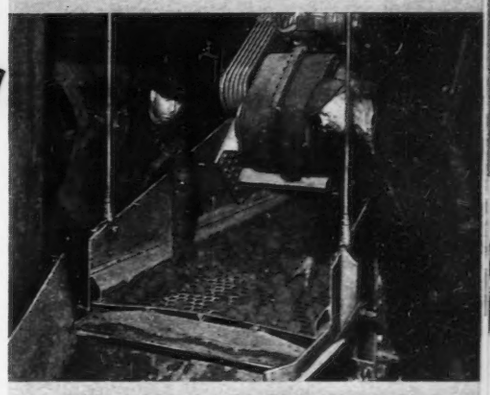

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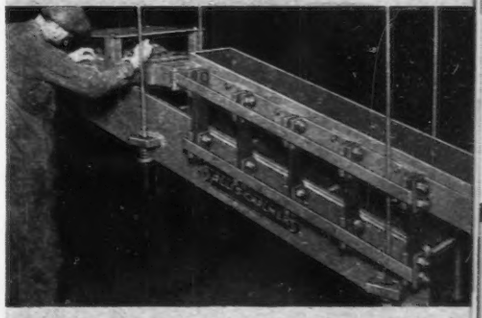

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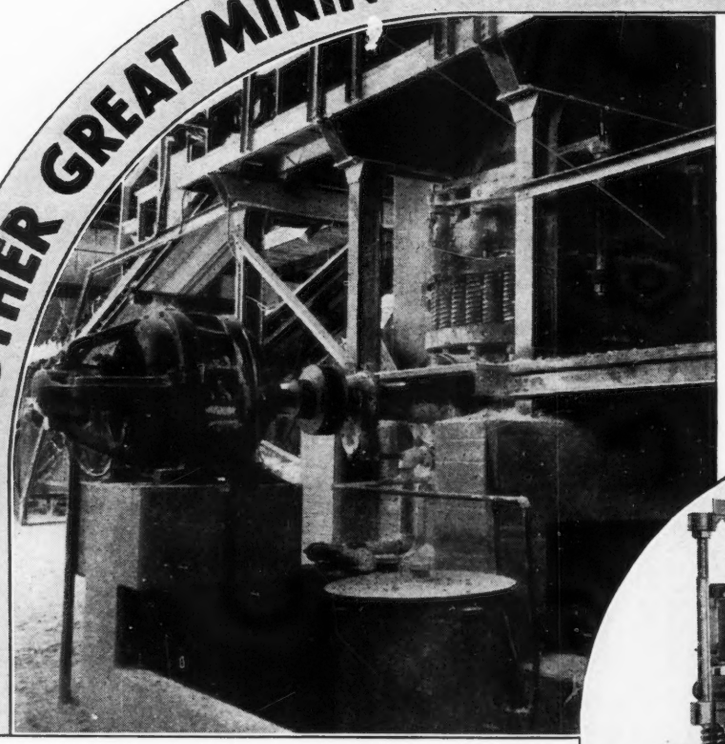
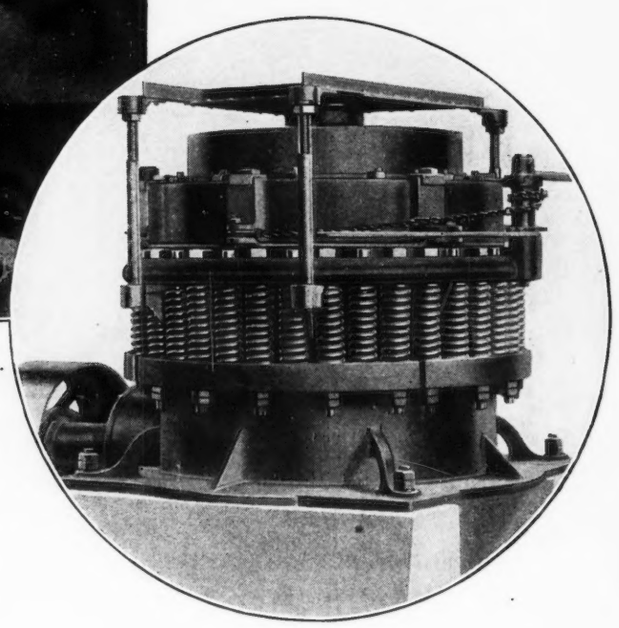


SYMONS CONE CRUSHERS



With Symons Cone Crushers in use by so many of the world's larger producers of zinc, it is not unusual that the American Zinc, Lead & Smelting Company is using four of these crushers for the fine crushing operations at its various properties in Tennessee. In the production of other metals also, Symons Cones because of their ability to crush finer and in greater capacity are a recognized factor in reducing overall crushing and milling costs, and in improving recovery. Available in both Standard and Short Head types, Symons Cones for secondary crushing meet today's demand for a more finely crushed product and an improved ball mill feed.

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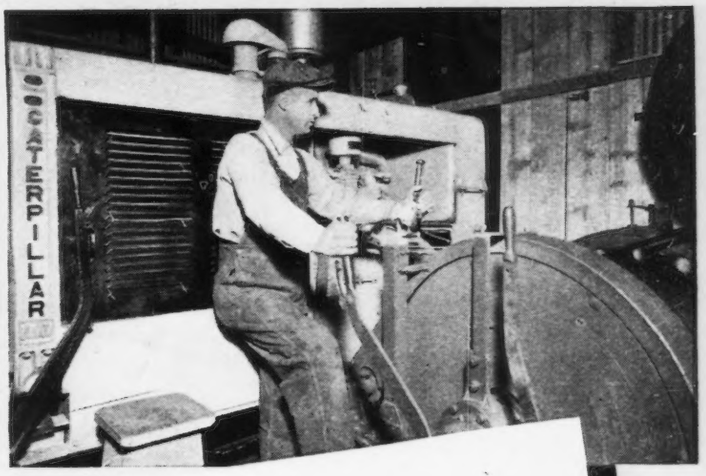
SYMONS CONE CRUSHERS

LOCAN MAKES A COMEBACK!



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TRACK-TYPE TRACTORS • ROAD MACHINERY

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Bear Xanthates help you maintain trouble-free operation and get good recoveries—two things you *have* to do to make a small flotation mill pay. Here are some of the reasons, as small mill operators themselves have written us:

"We have a small mill and do very little experimental work as long as we get satisfactory results," writes Mr. L. G. Cox, Mill Superintendent of North Canyon Mines, Inc., of Greenville, California. "We get good flotation results with Bear Xanthates."

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"Rapid action is what we like about Bear Xanthates," is the statement of Wm. Eathorne, partner with Mr. H. O. Fox in their gold operation at Corbin, Montana. "Furthermore, a little excess xanthate doesn't upset the froth."

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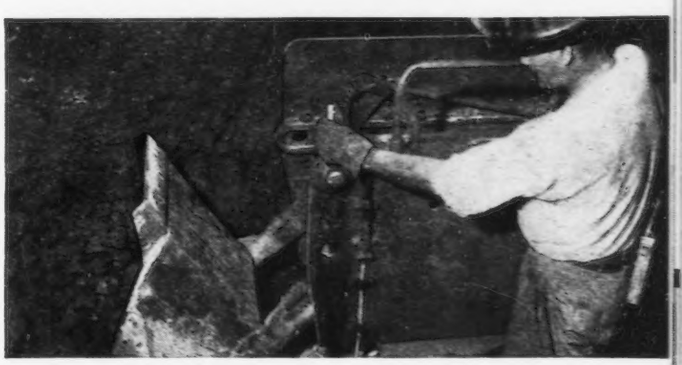
And send us a dimension sketch of your mine car for individual recommendations that will save money for *you* in *your* mine. There is no obligation. Gardner-Denver Company, Quincy, Illinois.

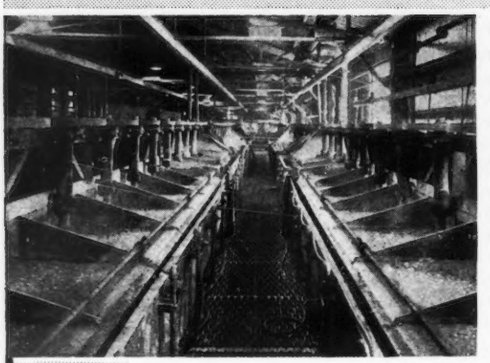
In a recent 3-month period, three GD-9 Loaders—in constant use in a large gold mine—mucked a total of 24,000 tons. Maintenance costs have been practically nothing, and the owner reports, "We couldn't manage without our GD-9 Loaders."



"Installing a Gardner-Denver Mine Car Loader in our mine speeded up production from 27 tons mucked per eight-hour shift to 68 tons mucked per shift," says the pleased superintendent of a money-making Western metal mine.

GARDNER-DENVER SINCE 1859

Over 100 MORSE-"WEINIG" FLOTATION CELLS *for one large* Copper Producer



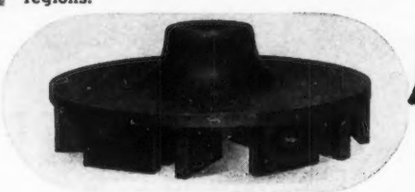
The SUCCESS of machinery is measured by performance and ability to function profitably for the owner. Proofs of entire satisfaction are repeat orders and increased demand. MORSE-"WEINIG" flotation machines are continually giving mechanical and metallurgical satisfaction, resulting in repeat orders and a growing universal demand for MORSE-"WEINIG'S" in base and precious metal mining regions.

Producing High Grade Silver-Lead Concentrate

Positive Air Control and pulp level regulation, combined with the "Weinig" Impeller, are exclusive reasons why Morse-"Weinig" Cells are dependable in giving the best in production of rougher and finished concentrate. Uniform and ideal froth conditions, resulting from thorough agitation and mixture of the pulp, air and reagents, alway prevail in Morse-"Weinig" Cells.

"Weinig" Cells—World's Largest Molybdenum Mill

Morse-"Weinig" Cells, for large operations, are supplied with "Weinig" Automatic Float Valve Pulp Controls or, if preferred, with Morse-"Weinig" Weir Gate Pulp Level Controls for each individual cell. All sizes of cells are designed for simplicity and accessibility of operating parts. Timken Bearings, precisely aligned in one peice bearing housings assure smooth, uninterrupted performance. Positive air control features approved by the most exacting operators.

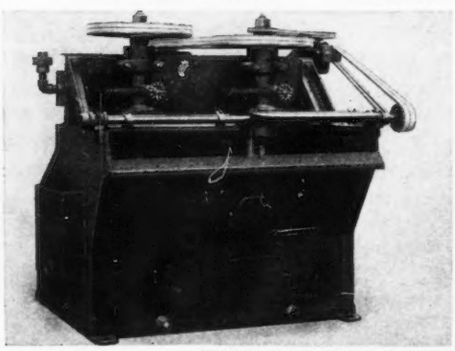


"Weinig" Moulded Rubber Impeller

"Weinig" Impellers Plus Positive Air Control

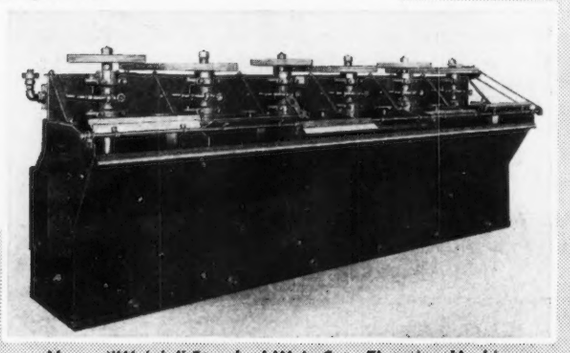
For Best Agitation and Metallurgical Results

"Weinig" Impellers function with high efficiency in producing intense agitation and a breaking up action, yet the uppermost parts of the cells maintain a quiet condition to aid in the production of concentrates. Hard-iron impellers are standard for all cells unless all-rubber impellers are specified.



Morse-"Weinig" Duplex Flotation Machine

The Duplex Machines fill a need for many applications and are made in sizes ranging from 10 up to 75 cu. ft. volume per cell. They are easy to install and operate.



Morse-"Weinig" Standard Weir Gate Flotation Machine

Morse-"Weinig" Cells are made of all-metal and quality materials. Tanks can be arranged for bolted or welded assembly at destination, thus reducing shipping volume to a minimum. Inquiries are solicited and will be given prompt and careful attention.

WRITE FOR LITERATURE

Machinery for Complete Ore-Dressing, Flowsheets & for all Characters of Ores

Head, Wrightson & Co., Ltd.
Stockton-on-Tees, England

1775 Broadway
New York City

Head, Wrightson & Co., (S.A.) Ltd.
Johannesburg, South Africa

ESTABLISHED 1898

MORSE BROS. MACHINERY CO.

P.O. BOX 1708 DENVER, COLORADO, U.S.A. CABLE "MORSE"

COMPLETE ORE-MILLING PLANTS · CONCENTRATION · FLOTATION MACHINERY · CYANIDE · AMALGAMATION

Perret & Brauen
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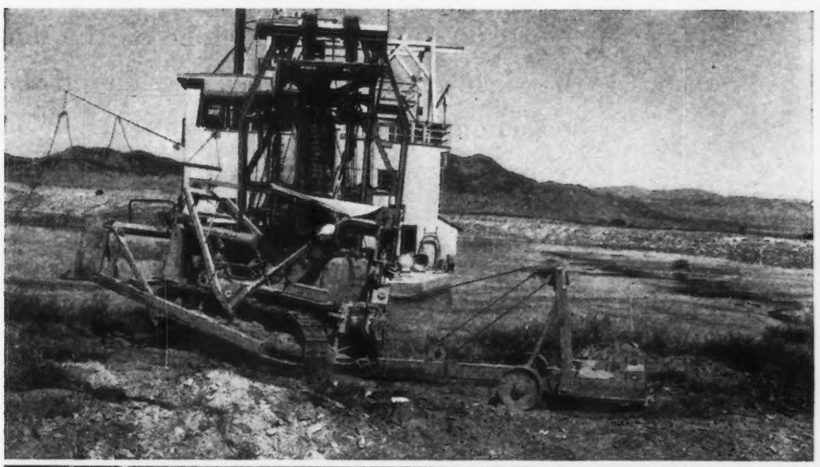
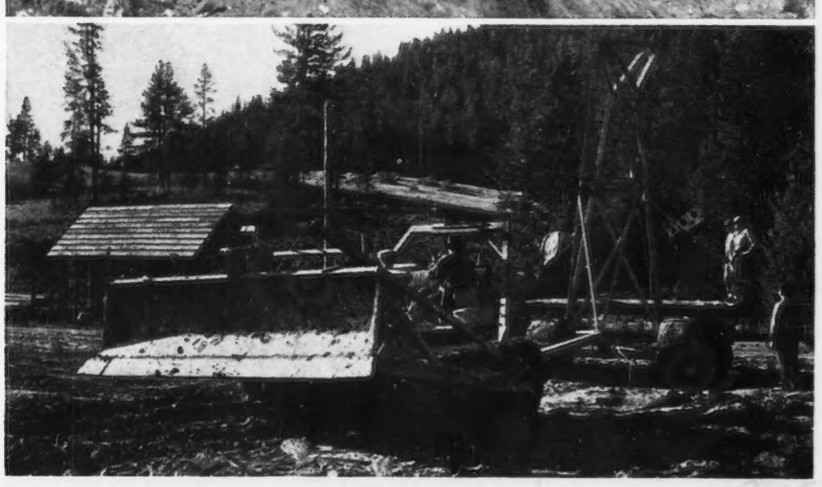
Bucchi C. & Cia Ltda.
Casilla 4603
Santiago, Chile, S. A.

Perret & Brauen
Caixa Postal 288
Rio De Janeiro, Brazil, S. A

YOU'LL FIND GOLD, TOO

in the Low Costs LeTourneau Mining Equipment Produces





Here's How Porter Brothers Cut Costs . . .

In Last Chance Gulch, outside Helena, Montana, this LeTourneau Angledozer-Rooter combination keeps hard, rocky overburden broken for easy, low-cost stripping... levels tailings, builds roads and digs feeder ditches for the dredge pond. Tough jobs, every one of them! Yet, here's what Porter Brothers' Corporation says about it:

6 Years' Use— Upkeep Practically Nil

"Our first piece of LeTourneau equipment, an Angledozer, (shown left) was originally installed on a 'Caterpillar' gas '50' tractor . . . repair costs on our LeTourneau equipment have been practically nothing since. We're well pleased with the performance of these tools."

Use LeTourneau Equipment on Two Properties

In addition to their Last Chance Gulch operation, Porter Brothers cleared another mining property from Granite, Oregon, woodsland with a LeTourneau Angledozer . . . dug a dredge pond with a Carryall Scraper . . . then hooked on this LeTourneau Tractor Crane and unloaded new machinery and supplies . . . all with the same tractor. You can't beat all-round savings like that!

See for yourself . . . by a demonstration right on your own property . . . how LeTourneau equipment will stretch your tractor's usefulness from one profitable mining job to the next. Ask your LeTourneau-"Caterpillar" dealer today!

LETOURNEAU

PEORIA, ILLINOIS • STOCKTON, CALIFORNIA

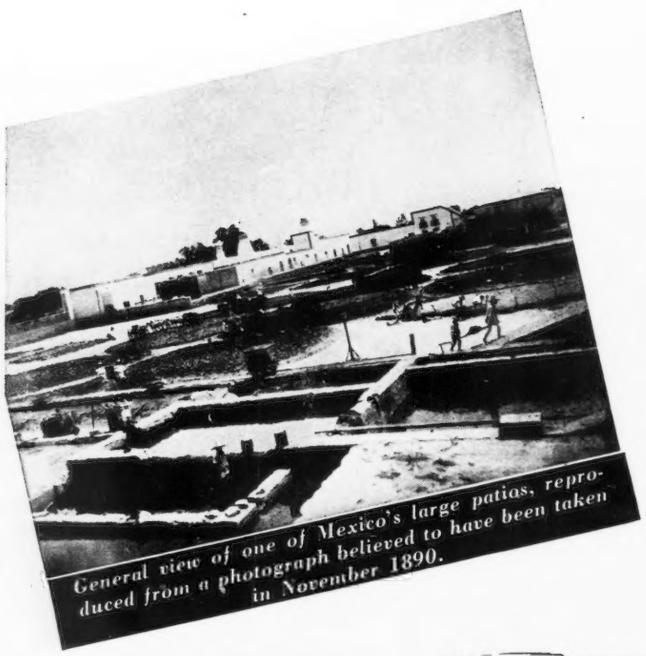
CARRYALL* SCRAPERS, ANGLEDOZERS*, BULLDOZERS, ROOTERS*, POWER CONTROL UNITS, DRAG SCRAPERS, CRANES, PUSHDOZERS, SHEEP'S FOOT ROLLERS, TOURNAPULLS*, TOURNATRAILERS*
Name Reg. U. S. Pat. Off.
Cable address: "Bobletorno"

Just fifty years ago · late in November 1890 · the patio mule drivers

plodded stolidly onward, all unknowing that half around the globe on the Rand the world's first commercial cyanidation plant was about to start its first run. After 333 years of amazingly high recoveries, considering its inherent simplicity, the patio was soon to be replaced by a new chemical process . . . cyanidation.

Viewed with considerable skepticism as a substitute for older beneficiation methods, cyanidation got its humble speculative start when the Gold Recovery Syndicate contracted to treat 10,000 tons of tailings for the Robinson Gold Mining Company. This rudimentary plant made "what had been regarded as a pretty chemical scheme into a sound commercial success."*

In its first six months, the Robinson Cyanidation plant increased recoveries to 75% overall, as compared to 63% by amalgamation alone. Within the decade recoveries approaching 90% on Rand ore were not uncommon and "practically the whole of the mines converted themselves into dividend payers . . . for it is a most remarkable fact that scarcely six of the Rand mines would today pay



General view of one of Mexico's large patias, reproduced from a photograph believed to have been taken in November 1890.

Artist's reconstruction of the world's first plant for the cyanidation of tailings of the Robinson Gold Mining Company, November 1890.

AMERICAN CYANAMID

A Complete Metallurgical-

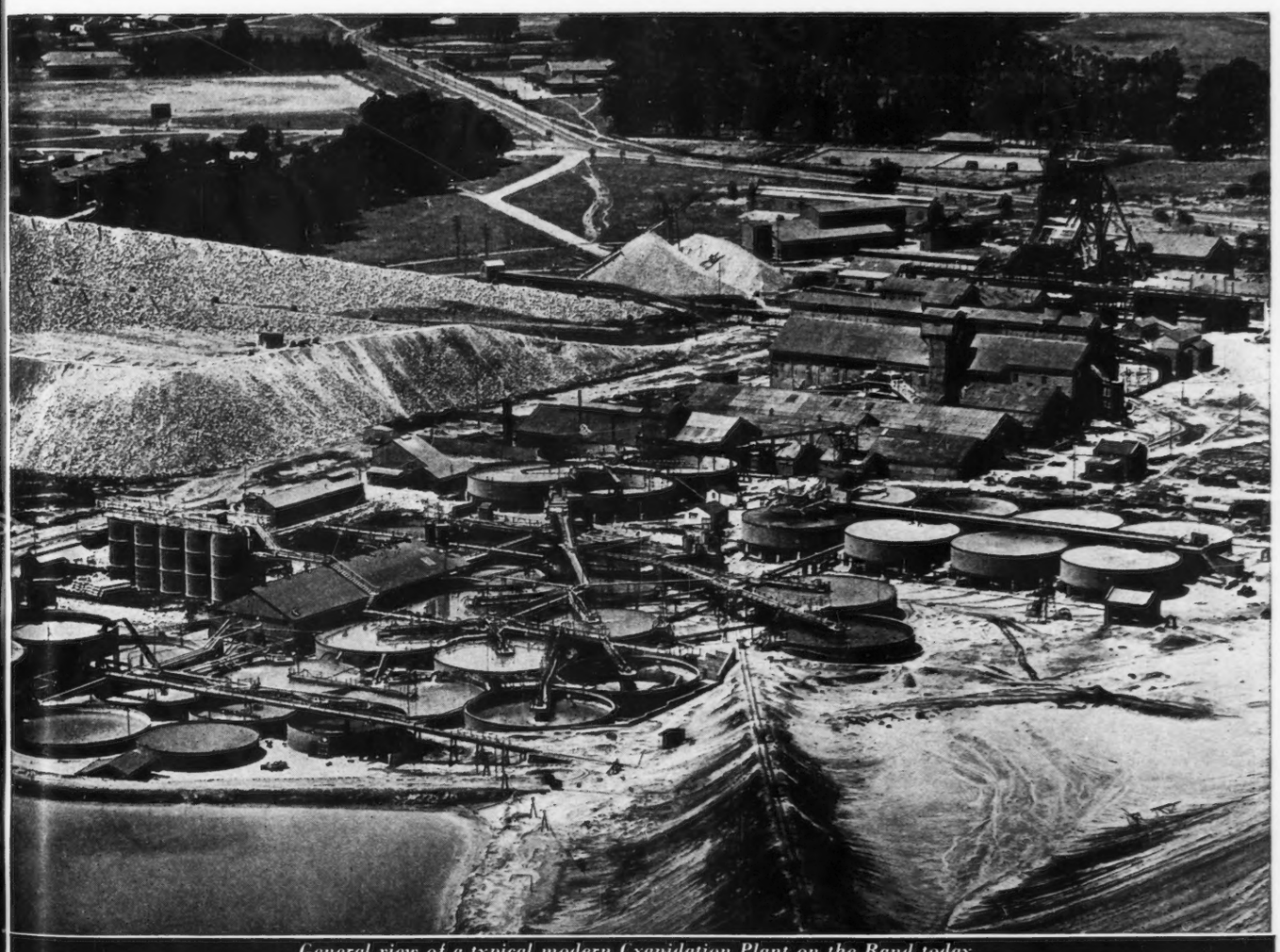
30 ROCKEFELLER PLAZA,

any dividends at all but for the profits received from the cyanidation of their tailings."*

In the first fifty years of cyanidation, reduction plants have been developed amazingly in comparison with the first crude "square vats", percolators and zinc boxes of the original Robinson plant. During this period comparable progress has also been made in the chemistry of the cyanidation process. Notwithstanding this progress, however, research goes steadily forward in the Cyanamid Ore Dressing Laboratory on the chemistry of various phases of the cyanidation process, on the cyanidation of refractory ores, on the cyanidation of flotation concentrates and in the development of new metallurgical chemicals.

In the year ahead Cyanamid confidently hopes and expects to provide the mining industry with even better technical service through Cyanamid Ore Dressing Laboratory and Cyanamid Field Engineers, as well as ample sources of supply for essential metallurgical chemicals through Cyanamid's production facilities.

**Alfred James: "Cyanide Practice", London, December, 1901.*



General view of a typical modern Cyanidation Plant on the Rand today.

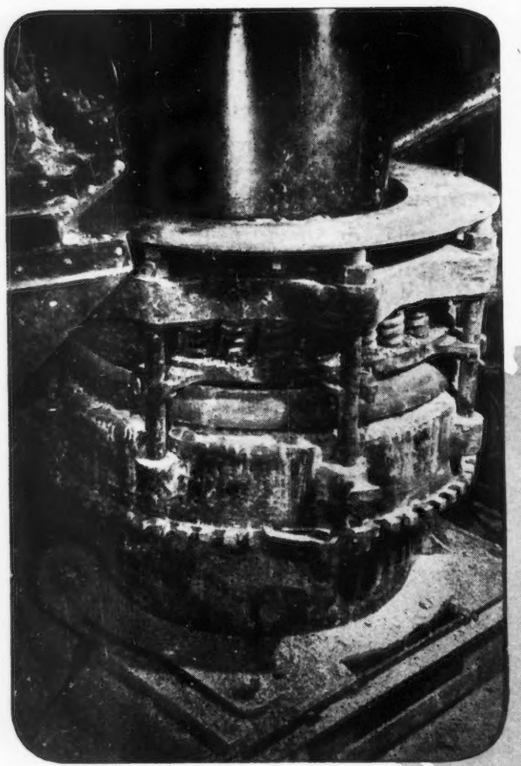
COMPANY
Chemical Service
NEW YORK

American Cyanamid Company
30 Rockefeller Plaza, New York, N. Y.

Please send me copies of Ore Dressing Notes which you have published on cyanidation and the cyanidation of flotation concentrates.

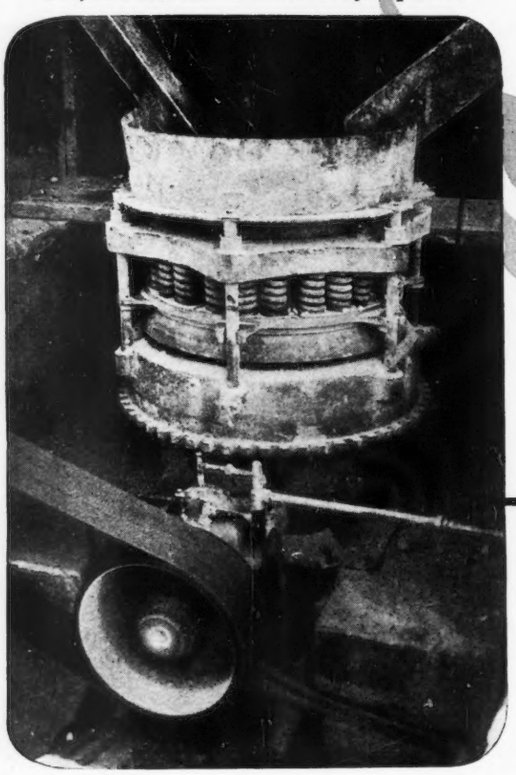
Name.....

Address.....



Turning out as high as 60 tons hourly, set for ¾" discharge—that's what this 36" Telsmith Gyrasphere Crusher is doing for the Granby Consolidated Mining, Smelting & Power Co., Ltd., at Allenby, British Columbia.

350 tons daily, with discharge set at ⅜" . . . even on damp and sticky ore . . . in the plant of Santa Maria de la Paz y Anexas in Matehuala, S. L. P., Mexico. Yes, it's another Telsmith Gyrasphere.



Canada TO Mexico

TOP TONNAGE AND A LOW COST PRODUCT WITH

TELSMITH

Gyrasphere

● Everywhere you go—in our own States, Canada, Mexico, South America or South Africa and so on—you mining men are getting an enormous tonnage at very low cost with Telsmith Gyraspheres. Just to look at the record, let's drop in for a minute on . . .

CANADA—Allenby, British Columbia—Granby Consolidated Mining, Smelting & Power Co., Ltd., has a 36" Telsmith Gyrasphere crushing the oversize from a 2" screen, maximum pieces about 2" x 5". What are they getting? As high as 60 tons hourly, with the Gyrasphere's discharge opening set at ¾". The manganese linings last about 8 months. And the crusher has needed no attention in the last 8 months.

MEXICO—Matehuala, S.L.P.—in the plant of Santa Maria de la Paz y Anexas. Here ore is trammed from surface bins to mill ore bin, reduced to 2" and fed to two vibrating screens. Then everything over ½" goes to their 24" Telsmith Gyrasphere, with its discharge opening set at ⅜". How's this Gyrasphere doing? Let's go right to the general manager for our answer. Ingenierio Victor Garate Valdes says the Gyrasphere is giving very satisfactory service even with damp and sticky ores, and they are well pleased.

In fact everybody is well pleased with the Gyrasphere. We think you'll be, too. *Bulletin Y-1 tells why.*

Min. 8

SMITH ENGINEERING WORKS

502 E. CAPITOL DRIVE, MILWAUKEE, WIS.

Cable Addresses: Sengworks, Milwaukee. Concrete, London

EXPORT OFFICE: 770-A Hudson Terminal Bldg., New York

Samuel Osborn (S. A.) Ltd. Johannesburg, So. Africa

Armco International Corp. Buenos Aires, Argentine

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Canadian Vickers, Limited, Montreal

Gordon Russell, Ltd., Vancouver

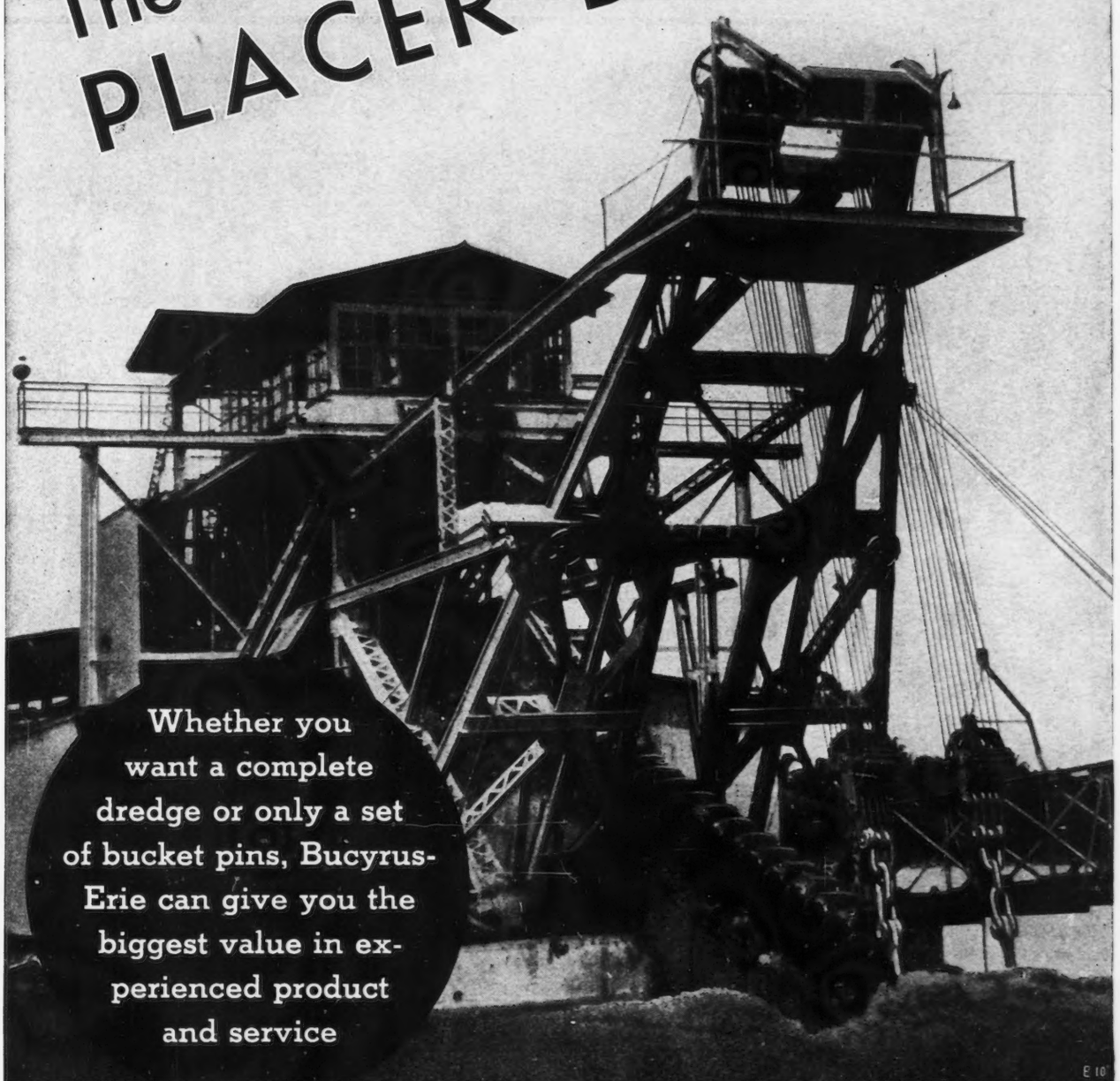
50 Church Street New York City

211 W. Wacker Drive Chicago, Ill.

Mines Eng. & Equip. Co. San Francisco, Calif.

General Agents for Western States: Mine & Smelter Supply Co., Denver, Salt Lake City, El Paso

The world's largest builder of PLACER DREDGES



Whether you want a complete dredge or only a set of bucket pins, Bucyrus-Erie can give you the biggest value in experienced product and service

E 10

Bucyrus·Erie

SOUTH MILWAUKEE, WISCONSIN

JACKBITS by the CARLOAD

LARGE USERS BUY JACKBITS BY THE CARLOAD

For some years a number of mines have been buying Jackbits by the carload. They know from experience.

For instance, in a western metal mine, an exhaustive test proved that Jackbits drilled 10% faster than conventional forged bits, and that deeper holes could be drilled with them. These features resulted in more tons of rock broken per shift and reduced bit costs appreciably.

Further substantial savings were made by reconditioning Jackbits with Ingersoll-Rand JMA Jackmill (hot mill) and the JF Jackfurnace.

Now this mine buys Jackbits by the carload.*

When you use Jackbits and I-R reconditioning equipment there is no divided responsibility. The Ingersoll-Rand Jackbit Line is complete.

The JMA Jackmill will resharpen Jackbits at the rate of 180 per hour. The cost of reconditioning bits with this machine usually runs around 3¢ a bit in the United States.

An extended test proved that Jackbits are a real economy measure whether used in small or large quantities.

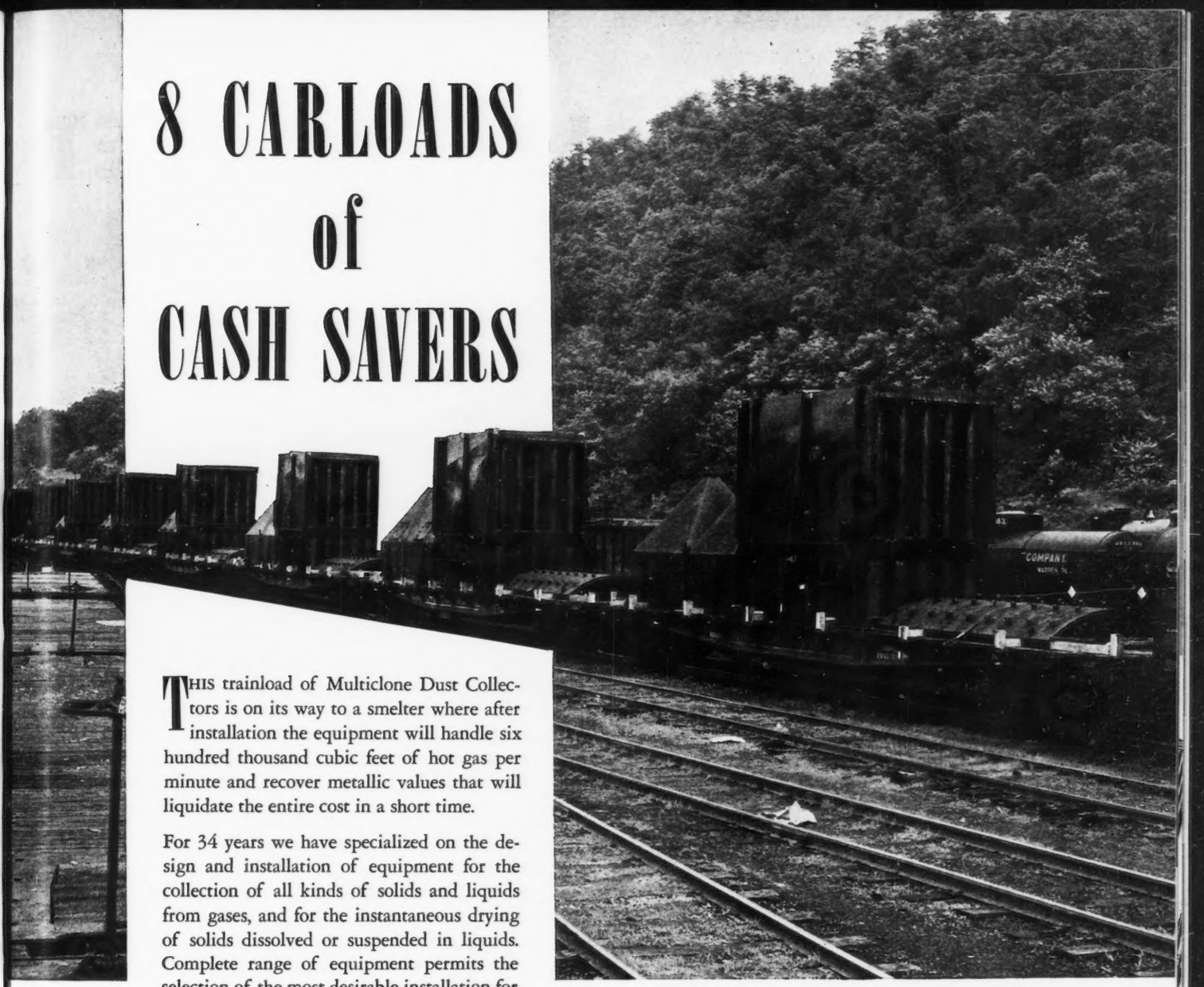
SOLVE YOUR DRILLING PROBLEMS WITH IR JACKBITS

Ingersoll-Rand

11 BROADWAY, NEW YORK CITY 970-15

Atlanta, Birmingham, Boston, Buffalo, Butte, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detroit, Duluth, El Paso, Hartford, Houston, Kansas City, Knoxville, Los Angeles, Newark, New Orleans, New York, Philadelphia, Picher, Pittsburgh, Pottsville, Salt Lake City, San Francisco, Scranton, Seattle, St. Louis, St. Paul, Tulsa, Washington

8 CARLOADS of CASH SAVERS



THIS trainload of Multiclone Dust Collectors is on its way to a smelter where after installation the equipment will handle six hundred thousand cubic feet of hot gas per minute and recover metallic values that will liquidate the entire cost in a short time.

For 34 years we have specialized on the design and installation of equipment for the collection of all kinds of solids and liquids from gases, and for the instantaneous drying of solids dissolved or suspended in liquids. Complete range of equipment permits the selection of the most desirable installation for your conditions from the standpoint of capacity, efficiency, kind of process and first cost. Cottrell Electrical Precipitators, Multiclone Mechanical Collectors, Spray Dryers and related equipment cover the entire field for the collection of particles suspended in gases or liquids, irrespective of particle size, character or temperature.

CERTAINTY OF PERFORMANCE WITH DEPENDABLE GUARANTEES

Thousands of installations operating at known efficiencies under specific conditions provide a background of experience that eliminates experimental hazards, and makes the determination of results to be obtained from new projects definitely dependable. Guarantees of capacities and efficiencies are validated by this experience, by adequate financial stability and records of operating installations.

Look around your plant today. If you have a dust, fog, fume or mist problem let us help you turn the losses to profits.

SEND FOR BULLETINS

WESTERN PRECIPITATION CORPORATION
1016 West Ninth Street, LOS ANGELES • 405 Lexington Avenue, NEW YORK • 140 South Dearborn Street, CHICAGO
Hobart Building, SAN FRANCISCO

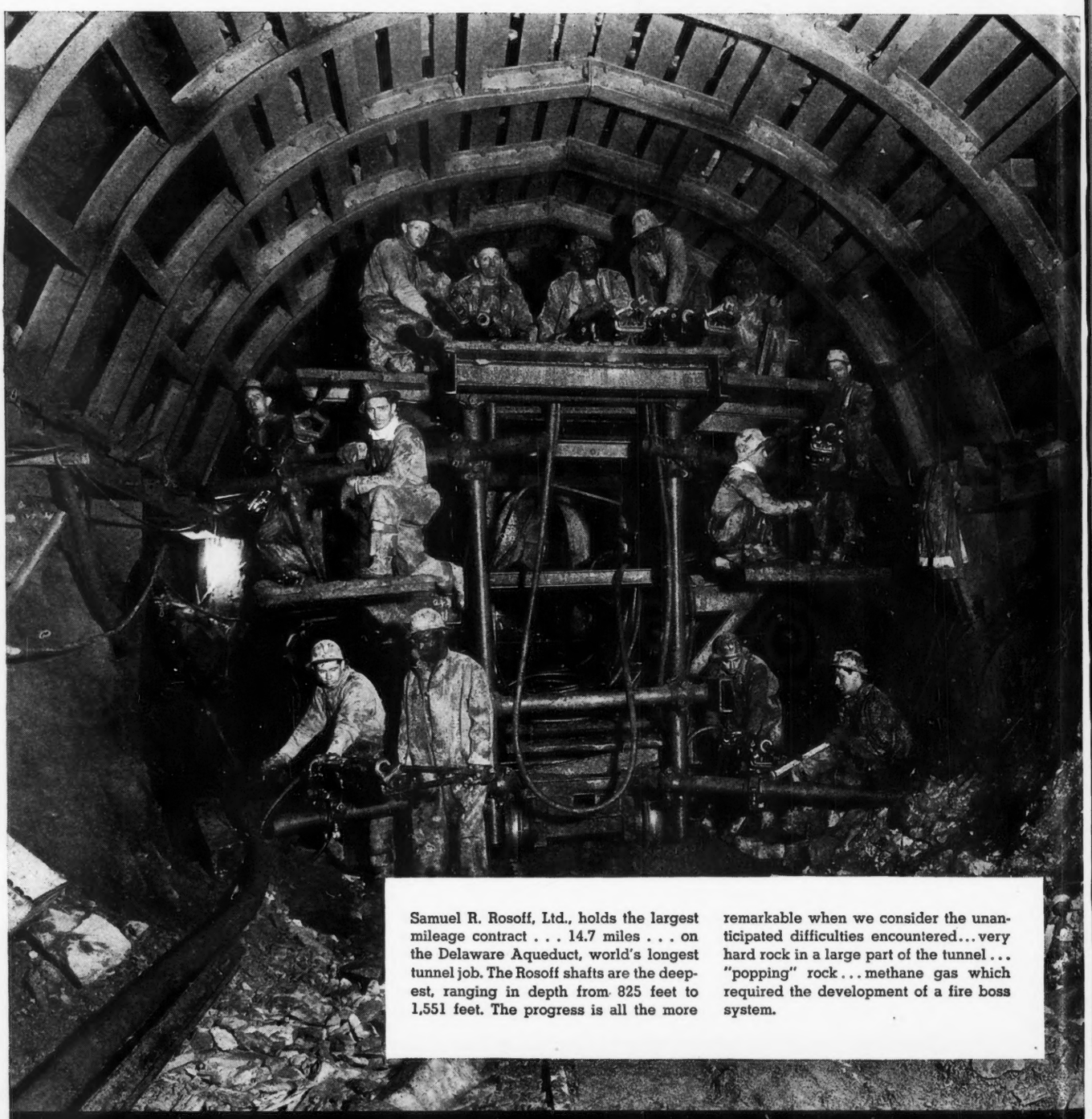
PRECIPITATION CO. OF CANADA, Ltd.
Dominion Square Building, MONTREAL, QUEBEC

REPRESENTATIVES IN PRINCIPAL CITIES

Pioneers in Dust, Fog, Fume and Mist Control

MULTICLONE
DUST COLLECTORS
COTTRELL
ELECTRICAL PRECIPITATORS

6,779 LINEAR FEET OF TUNNEL . .



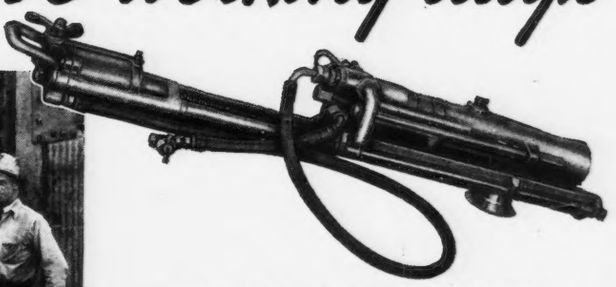
Samuel R. Rosoff, Ltd., holds the largest mileage contract . . . 14.7 miles . . . on the Delaware Aqueduct, world's longest tunnel job. The Rosoff shafts are the deepest, ranging in depth from 825 feet to 1,551 feet. The progress is all the more remarkable when we consider the unanticipated difficulties encountered... very hard rock in a large part of the tunnel . . . "popping" rock . . . methane gas which required the development of a fire boss system.

CHICAGO PNEUMATIC

GENERAL OFFICES: 6 EAST 44th STREET, NEW YORK, N.Y.

. . . AND STEEL SUPPORT

in 31 consecutive working days



This is the CP MOTORdrifter which is helping Rosoff crews to outstanding performance on the Delaware Aqueduct.

Operating Staff, Samuel R. Rosoff, Ltd.:
David E. Stinson, General Master Mechanic;
James Fisher, General Superintendent;
Philip S. Miller, First Assistant Engineer;
Fred W. Stiefel, Chief Engineer;
Arthur H. Diamant, Vice President;
W. Quick, Superintendent, Shaft No. 2-A;
Walter Dunham, Superintendent, Shaft No. 3;
L. S. Penland, Superintendent, Shaft No. 2.

Board of Water Supply Engineers:
John G. Mergott, Asst. Engr. — Max F. Freund, Division Engr.
Roderick C. St. Leger, Asst. Engr. — Arthur E. Hilliard, Asst. Engr.
Francis J. Colgan, Asst. Engr. — John Horn, Asst. Engr.
Through typographical error, the above group was referred to as Inspectors instead of Engineers in a previous advertisement.

Samuel R. Rosoff, Ltd., is setting new progress records on the Delaware Aqueduct, New York.

Here are some typical figures:

At Shafts Nos. 2, 2-A and 3; six headings; 6,779 linear feet of tunnel were driven in 31 consecutive working days, with steel support directly to the face of each heading, using crown bars.

3,760,000 pounds of structural support were erected in the same period; 176,200 feet board measure of timber were used.

This is equivalent to driving 10,075 linear feet of unsupported tunnel for the same period, 31 consecutive working days.

The actual value of the work performed during this period was $1,117,987.00.

CP-60 Drifters were used exclusively in drilling this footage.

For complete data on the CP-60 MOTORdrifters which are giving such outstanding performance on the world's longest tunnel job, send for copy of Catalog No. 600, "CP Contractors' Equipment".

TOOL COMPANY

SALES OFFICES AND SERVICE STATIONS THROUGHOUT THE WORLD

● **Hattie's doting on her operation and recovery is largely imagination —but here is an operation and recovery story that is making mill men sit up and take notice—One Agitair owner states:**

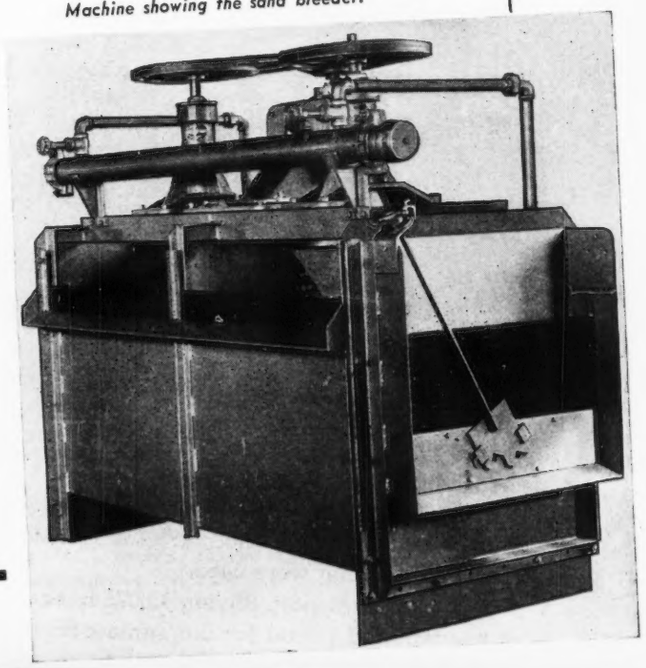
"We are enthusiastic over the easy, positive operation and improved recoveries of the Agitair. These qualities have resold the Agitair to our firm."

The Agitair's intense aeration and agitation at the cell bottom makes it the most economical and smooth running machine on the market. After an initial installation you will be convinced of the superiority in the design of the Agitair Flotation Machine. Once installed, the Agitair—LASTS! Maintenance in actual plant investigation shows a cost of less that 2/5 of 1 cent per ton of ore treated.

The art of separating the values of your ore from the gangue can be completely entrusted to the Agitair with all confidence. The principles of flotation separation have been carefully engineered and constructed into this machine by skilled engineers and technicians. These facts are confirmed in actual commercial tests in competition with other flotation machines—THE AGITAIR LEADS.

The benefits that have proven profitable to operators on both hemispheres are available to you. Let us mail you further information today as to the many quality features of this machine, and its application to your operations. Address Dept. A-9.

End view of the Agitair Flotation Machine showing the sand bleeder.



THE GALIGHER COMPANY

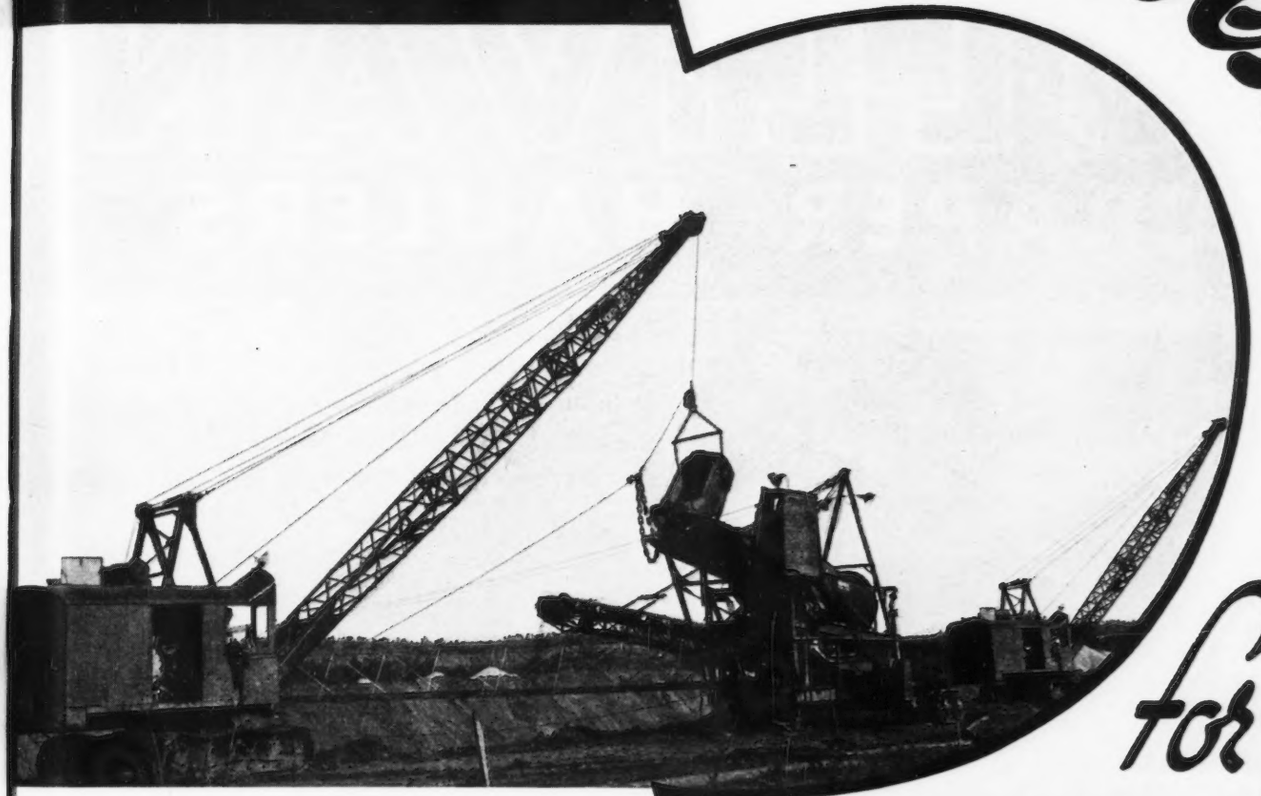
ORE TESTING LABORATORIES

British Mining Supply Co. Ltd. (Pty.)
Johannesburg, So. Africa

Established 1901

Booth Thompson Metallurgical Division
228 So. West Temple. Salt Lake City, Utah

A second Northwest



for

PANOB GOLD DREDGING CO.
LOOMIS, CALIF.

WHETHER it's gold dredging or working over old tailings, the cost of machine operation makes or breaks the profits.

The economy of Northwest operation, the low fuel consumption, the fast trouble-free operation, have combined for many repeat orders from mining properties—and there is no better testimonial to profit earning ability than a repeat order.

Northwests bring the mining property exclusive advantages that cut costs and save time. Northwest Differential Steering with positive traction on both crawlers while turning as well as when going straight ahead takes the Northwest where other machines go with difficulty. The "feather touch" Clutch Control, the Cushion Clutch, Uniform Pressure Swing Clutches, the Helical Gear Drive, are but a few of the advantages that combine for easier operation and reduced maintenance problems. We can't tell you in detail about them here, but if you are in the market for a shovel, crane or dragline, regardless of size, we urge you to write for complete details before you buy.

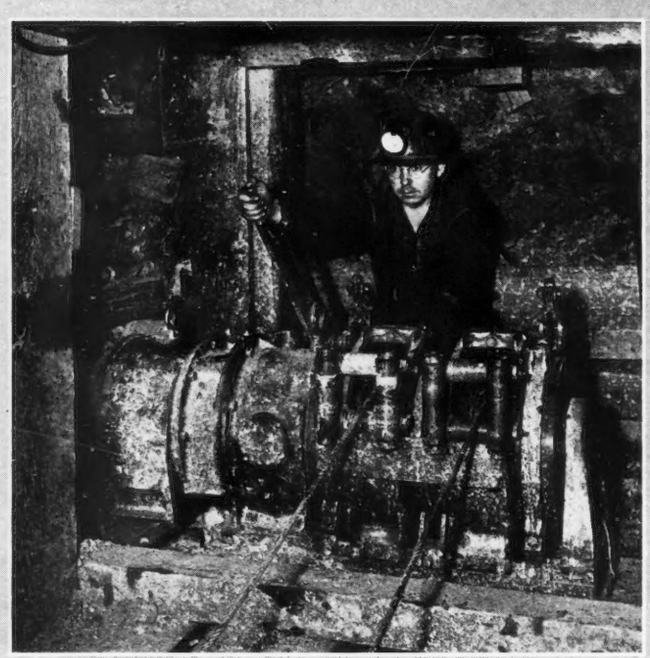
NORTHWEST ENGINEERING COMPANY
1806 Steger Bldg. • 28 E. Jackson Blvd. • Chicago, Ill.

NORTHWEST

Shovels • Cranes • Draglines • Pullshovels

Buy for the tough jobs and the easy jobs take care of themselves

500 MILLION TONS OF SCRAPING SATISFACTION WITH SULLIVAN SCRAPER HAULERS



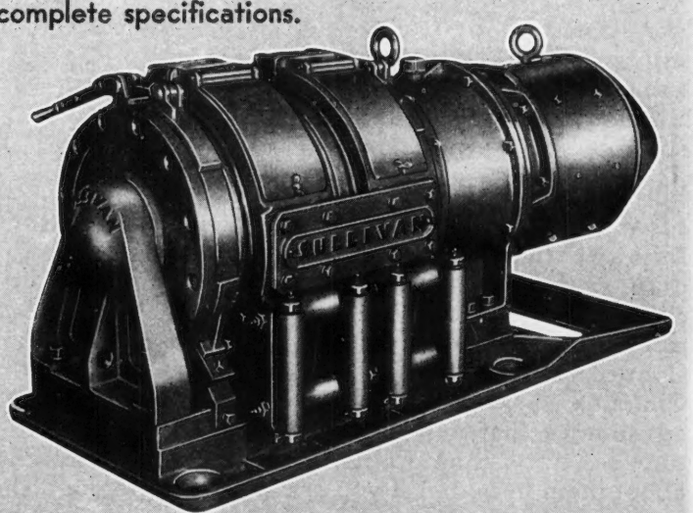
The popular BF-212 in a large copper mine in Nevada.

SINCE 1915 when the Sullivan Machinery Company built the first double drum scraping machine—engineers have estimated that the more than 12,000 units—built for operation in every country of the world—have scraped between 475 and 525 million tons of material.

These 12,000 units of progress have provided a wealth of design experience not obtainable in any other way. It is only natural, then, that Sullivan engineers, in cooperation with practical mining men, have developed every important improvement found in good scraping machines of today.

That's why thousands of progressive mines are now satisfied users of Sullivan scraper haulers. Are you taking advantage of Sullivan's most modern design features? Write—Now. Ask for Bulletin No. 76-Y, which gives you complete specifications.

STANDARD AF, BF AND CF TYPES have flange-mounted motors and are regular equipment for most of the ordinary scraping jobs. Identical in construction, they incorporate such features as: Positive pressure lubrication, anti-friction bearings, faster tail rope speeds, universal rope guides and rope guards, two-lever control, cast steel skid-type frame, large drum diameters, and removable motor head and bearings—made in more than 100 different types and sizes, from the "AF", with a rope pull of only 1600 lbs., to Type "CF", with rope pulls to 6500 lbs., rope speeds to 305 feet, and drum capacities to 1000 feet of 1/2" rope.



FOR ALL AROUND ECONOMY USE SULLIVAN 2 and 3 DRUM SCRAPER HAULERS

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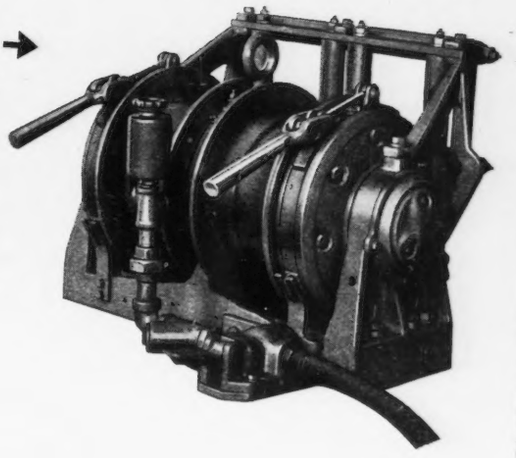
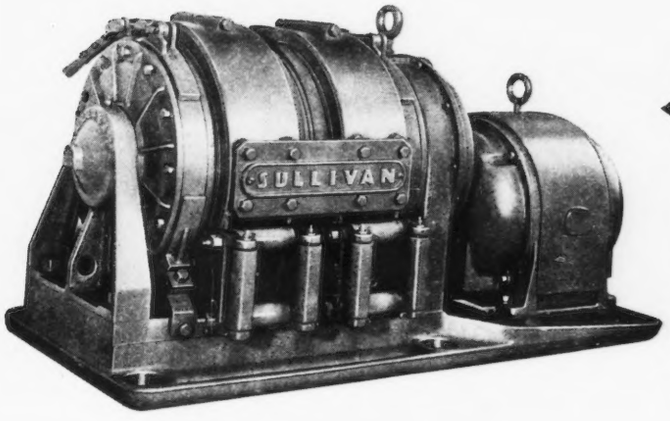
There's a Sullivan Scraper Hauler for Every Type of Job and Every Kind of Drive

TURBINAIR SCRAPER HAULERS are economical to operate, rugged and compact in design but lighter in weight per horsepower developed, than any other air-driven hauler on the market. Turbinair motors, well known for their reserve power, will momentarily pull loads of more than 2½ times their rated rope pulls — due to inertia of the rotors which can be built up by releasing the clutch and spinning the rotors — a definite advantage when scraping large boulders. Type "F" turbinair haulers are made in three rope capacities, with pulls of 2000 lbs., at a speed of 125 feet per minute.

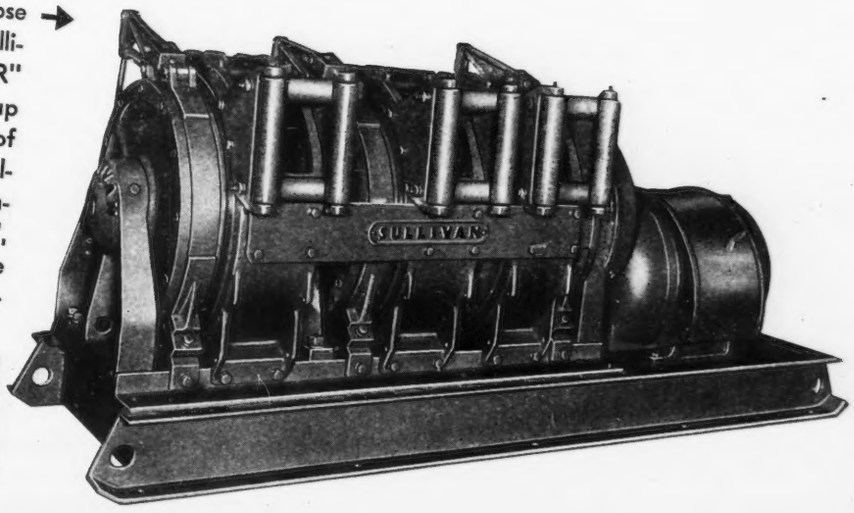




SPECIAL A, B, C MODELS with all the advantages of the AF, BF and CF types are made for use with base-mounted motors—they provide for interchangeable air or electric drive for mines equipped mainly with air power which later expect to completely electrify. They are also used in headings for slide work where the exhaust air for ventilation purposes is desirable, and in unusually wet headings where electricity may not be used.

HEAVY DUTY HAULERS. For those large tonnage scraping jobs, Sullivan builds the "K", "P" and "R" heavy duty types with rope pulls up to 15,700 lbs., with a rope speed of 210 F. P. M. These heavy duty haulers embody many of the advantages found on the popular "AF", "BF" and "CF" types and provide the same trouble-free, low cost operation.

TYPE	H. P.	ROPE	
		Pull lbs.	Speed F.P.M
K-211	50	7,500	220
P-211	75	10,000	245



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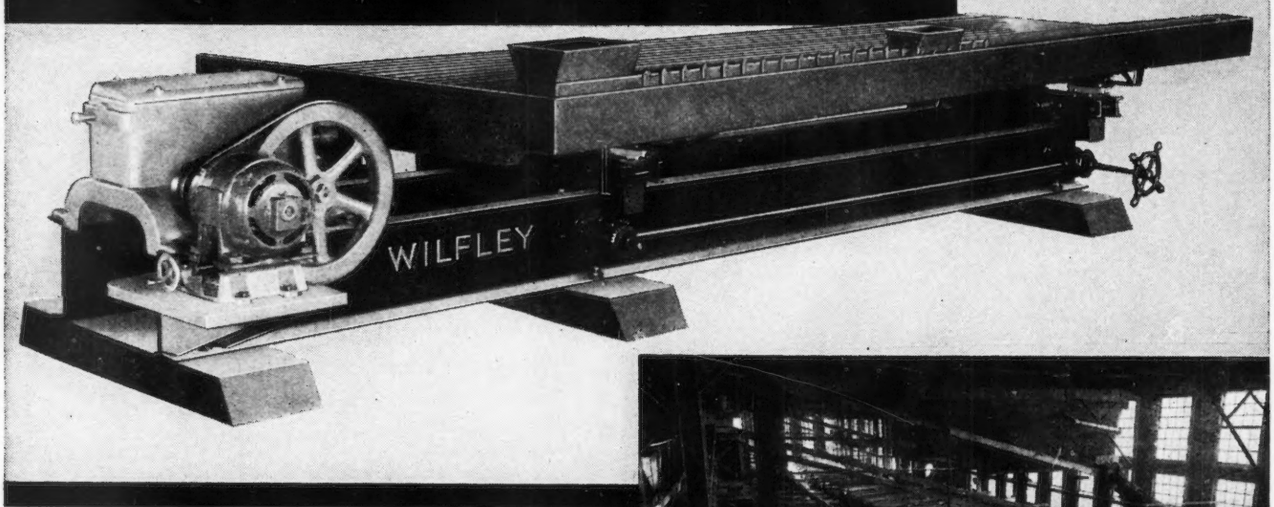

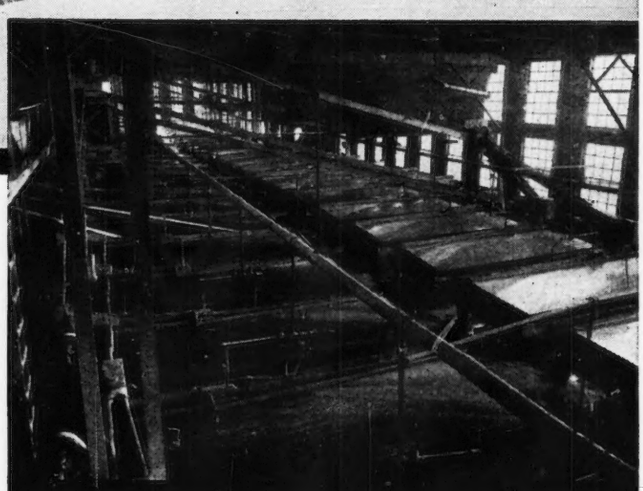

WILFLEY TABLES

Maximum results in table concentration are a matter of controlling the variable factors. Constant refinement of mechanical devices for operation, regulation and adjustment have kept genuine **WILFLEY** tables in continued preference for these many years.

Individual motor drive is available with variable speed control, permitting a speed range from 250 to 320 R.P.M. By a simple screw adjustment, stroke length may be varied from ¾" to 1¾" without reducing the effectiveness of the differential. The deck is light, but so well designed and reinforced that it stays absolutely flat. Special sheet rubber provides a more satisfactory surface and longer wear.

Various types of frames, such as 12" channel steel, guarantee rigidity. These and many other **WILFLEY** features combine to produce more exact separations of both metallic and nonmetallic minerals. Write for Bulletin 64-B.

WE ALSO MANUFACTURE

MARCY Ball, Rod and Tube Mills; Density Controllers; Amalgamators; Reagent Feeders; Rubber Pinch Valves; G-B Portable Placer Machines . . . Mine and Mill Supplies; Laboratory Supplies--- COMPLETE MILLING PLANTS.

★ **The world-wide ore milling experience of Mine and Smelter's staff is at your service---for council and cooperation with your own consultants.**

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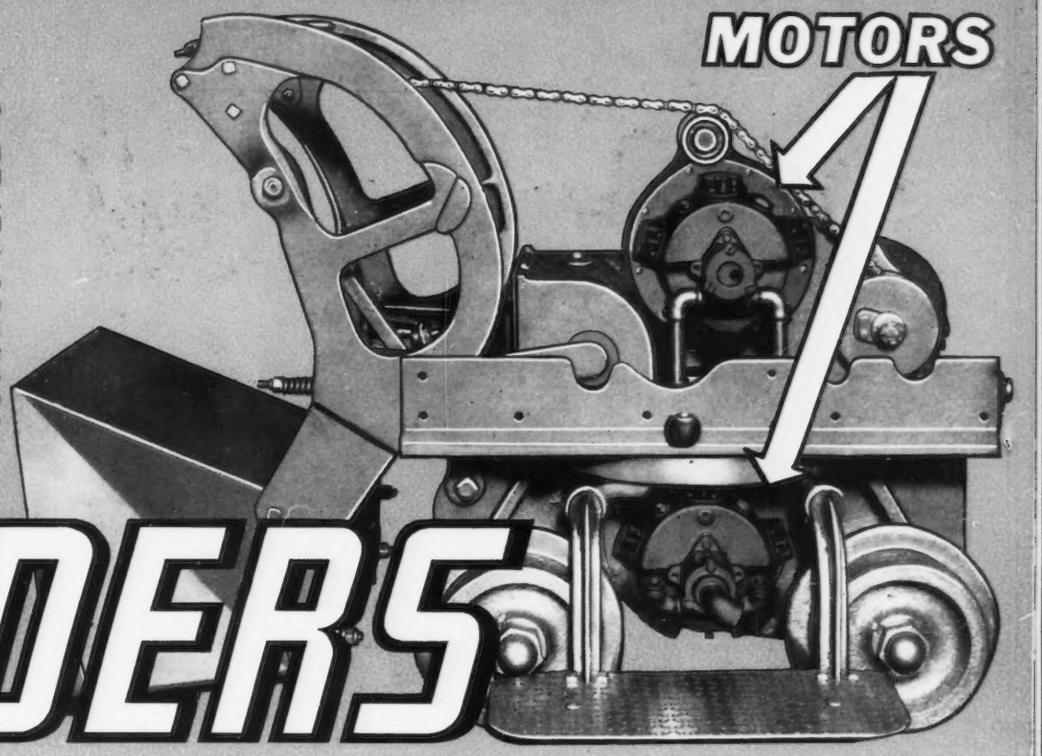
GREATER LEVERAGE GIVES GREATER DIGGING POWER

The illustration at right shows the simple powerful construction of Eimco's patented rocker-arm and bucket assembly. Its operation is equally simple . . . merely a rolling over backward on two flat parallel tracks when power is applied to the pull-back chain.

Because the Eimco-Finlay Loader applies LEVERAGE to its bucket action so much more effectively than any other type of mucking machine it performs MORE USEFUL WORK in a given amount of time with only about half the power requirements and with correspondingly lower air consumption. Its wide margin of reserve power is only needed when air pressure is low or when some unusually heavy load is encountered.



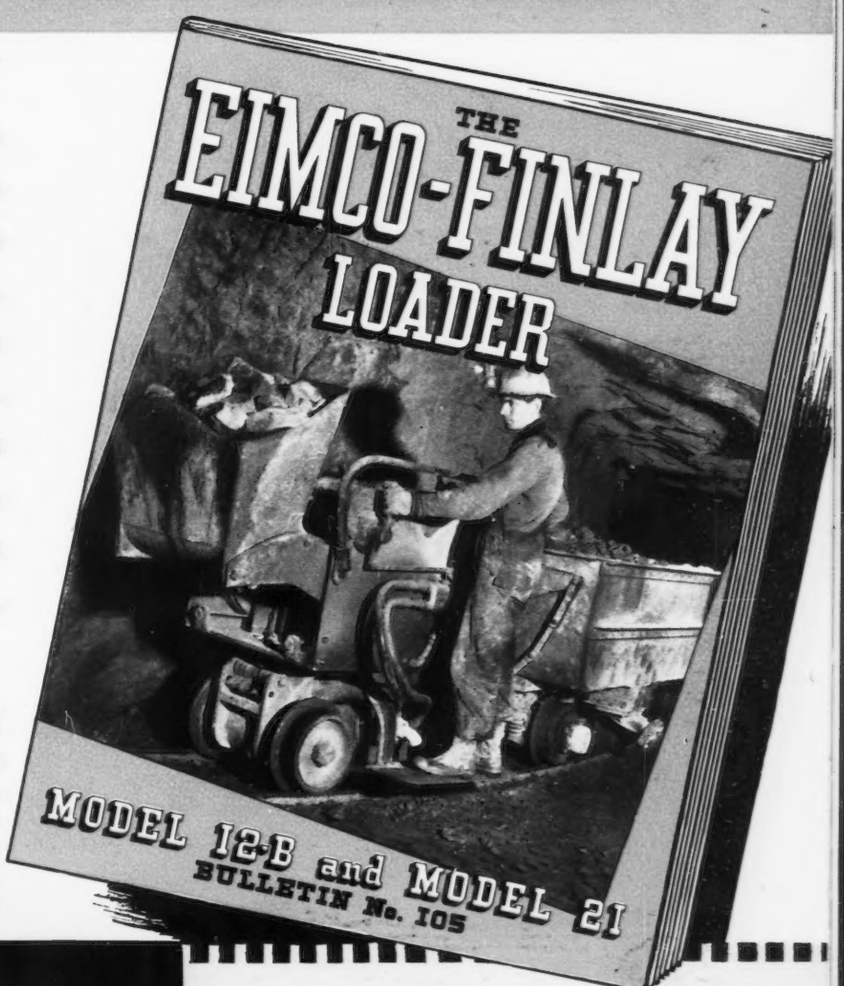
LOADERS

OUR GUARANTEE

Year after year, far more Eimco-Finlay Loaders are manufactured and sold than all competitive types combined, and their inherent superiority has been so thoroughly proved that every Model 12-B or Model 21 machine now carries a positive, money-back guarantee that it will outlast and outperform any other mucking machine on the market, of comparable size and type, at any air pressure and under any working conditions.

DETAILS FURNISHED PROMPTLY ON REQUEST

Our new fully-illustrated 36-page Bulletin No. 105 gives complete information regarding the design, construction and operation of Eimco-Finlay Loaders, together with many examples of important savings secured through their use in modern mines and tunnels. Write for it today, or use the convenient coupon.



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I am interested in mechanical loading and would like to receive a copy of your new Bulletin No. 105, with the understanding that no charge or obligation of any kind will be incurred.

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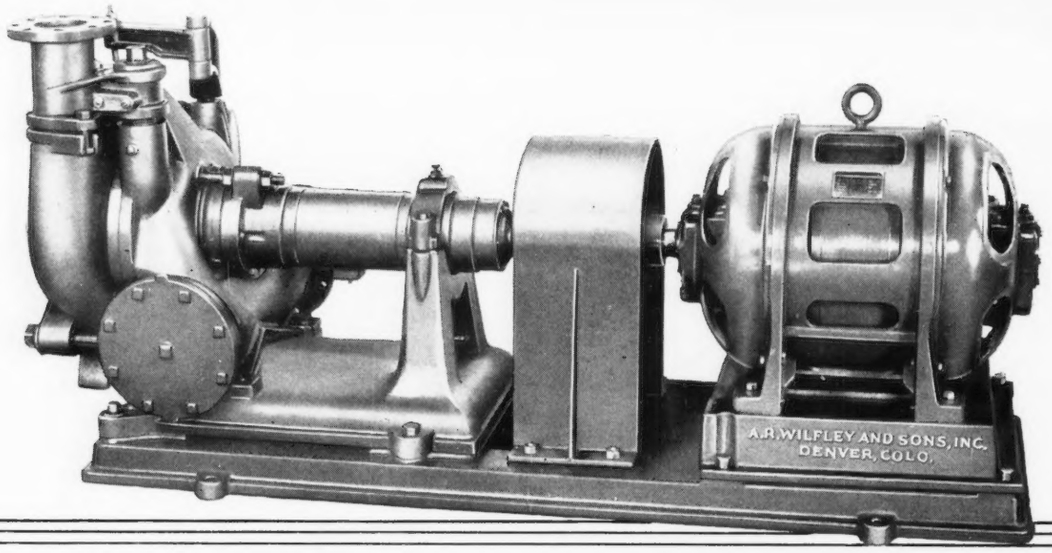

Build PROFITS *with* PERFORMANCE

Get TRUE *High Efficiency!*

If you want a pump that CUTS operating costs through HIGH EFFICIENCY in handling sands, slurries and slimes, investigate this new Wilfley HIGH EFFICIENCY pump. This is the pump that runs continuously, 24-hours a day *without attention*. It delivers DEPENDABLE performance that makes pumping troubles a thing of the past, and definitely reduces the cost of your pumping operation.

Heavy pumping parts made of the specific material that works best on YOUR job. Rubber, alloy iron, alloy steel each has its application. Wilfley supplies the exact combination that gives best results in YOUR plant. Complete engineering service. Prompt shipment of parts.

If you want to end pumping troubles, save costs and increase profits, write today for complete details of the new HIGH EFFICIENCY Wilfley.

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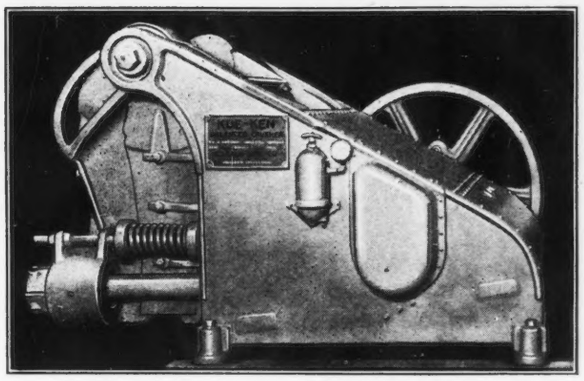
centrifugal PUMPS

You CAN Increase Mill Capacity

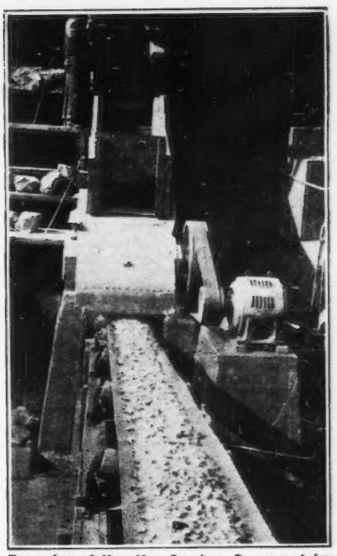


WITH A KUE KEN CRUSHER

You reduce grinding time as much as one half because Kue Ken delivers a finer mill feed. Ore moves from mine to Kue Ken and direct to mill without secondary crushing. From Mine Run to mill feed in a single pass.

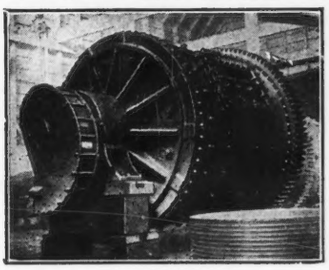
Capacity Doubled At This Mine!

Ore is crushed six times as fast and mill is grinding the finer feed twice as fast as previously. Costs are greatly reduced because Kue Ken requires the minimum of power and upkeep. Man-hour costs are cut because mill capacity is doubled. Name of this mine will be sent on request.



Rear view of Kue Ken Crusher. Conveyor takes rock direct to mill.

All Steel RIB CONE BALL MILLS



This is a 100 ton DB type Rib Cone Mill. There are over 70 sizes and types for your selection. Get the right mill for your job . . . no compromise.

Strong, light weight, all steel construction means longer wear, less power requirements. Bigger bearings wear longer and run cooler. Patented Spiral Lifter Ribs plow the ball charge to feed end where the grinding is done most efficiently. End to end circulation means rapid discharge which eliminates costly and useless overgrinding. Any way you look at it Straub Mills will cut your costs. FREE CATALOG will be sent without obligation.

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60 Pages of Cost Cutting, Time Saving, Job Simplifying Ideas for Mining Men!

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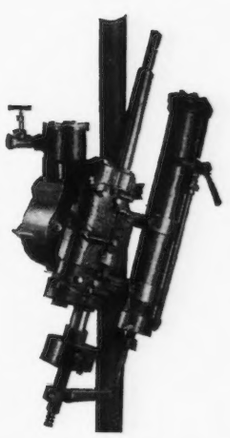

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ONE OF OUR MOST ADAPTABLE LIGHT AIR-DRIVEN DIAMOND DRILLS.

WEIGHT—Only 175 lbs.

COMPLETE WITH ROD PULLER.

Drilling capacity with "LE" rods 250 feet. "XR" rods 500 feet. Size of core recovered (EX and XR) 7/8" and 3/4" diameter respectively. Standard mine bar mounting.

A complete line of Diamond Drilling equipment.

PROMPT ATTENTION TO ENQUIRIES WHETHER FOR SALES OR CONTRACT.

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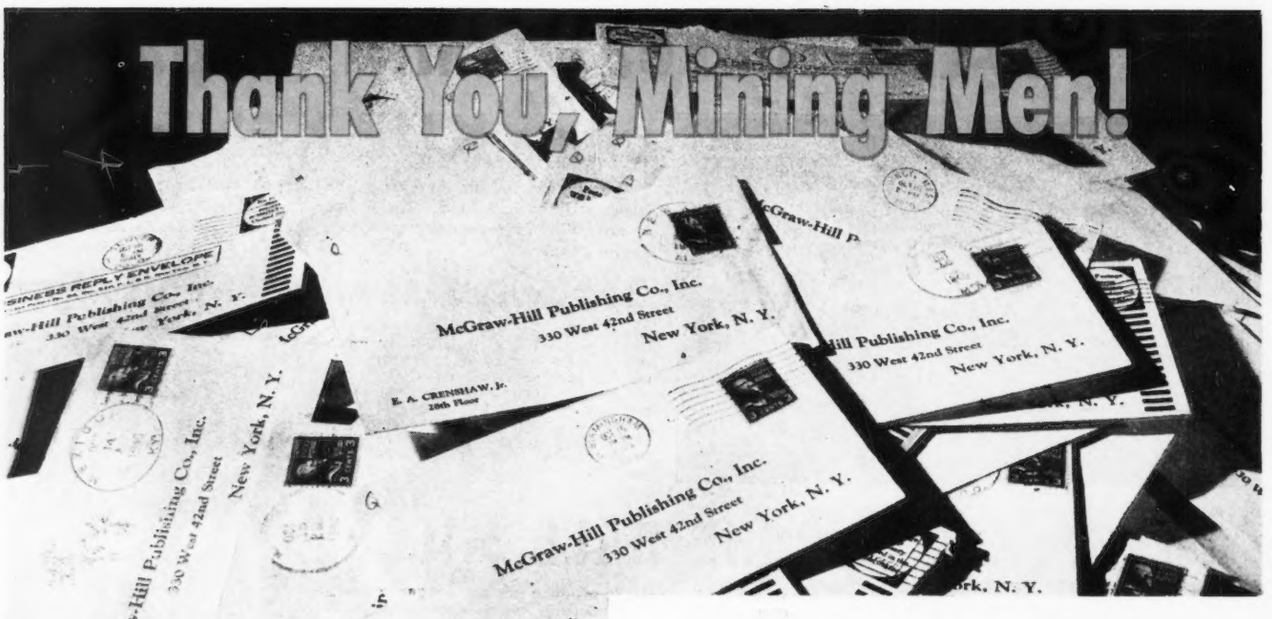

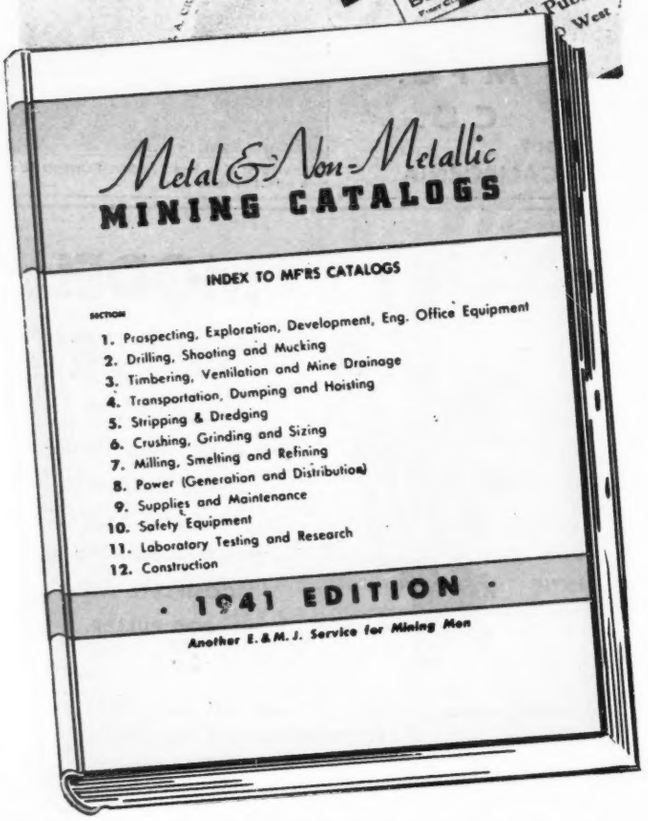
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Another E. & M. J. Service for Mining Men

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As a result of these comments we are preparing a better and more usable Catalog for 1941.

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The volume of replies makes it impossible to answer each one individually — as we would like to do — so we use this method to acknowledge them and to say "thank you" for your cooperation.

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E.&M.J. Dec. '40

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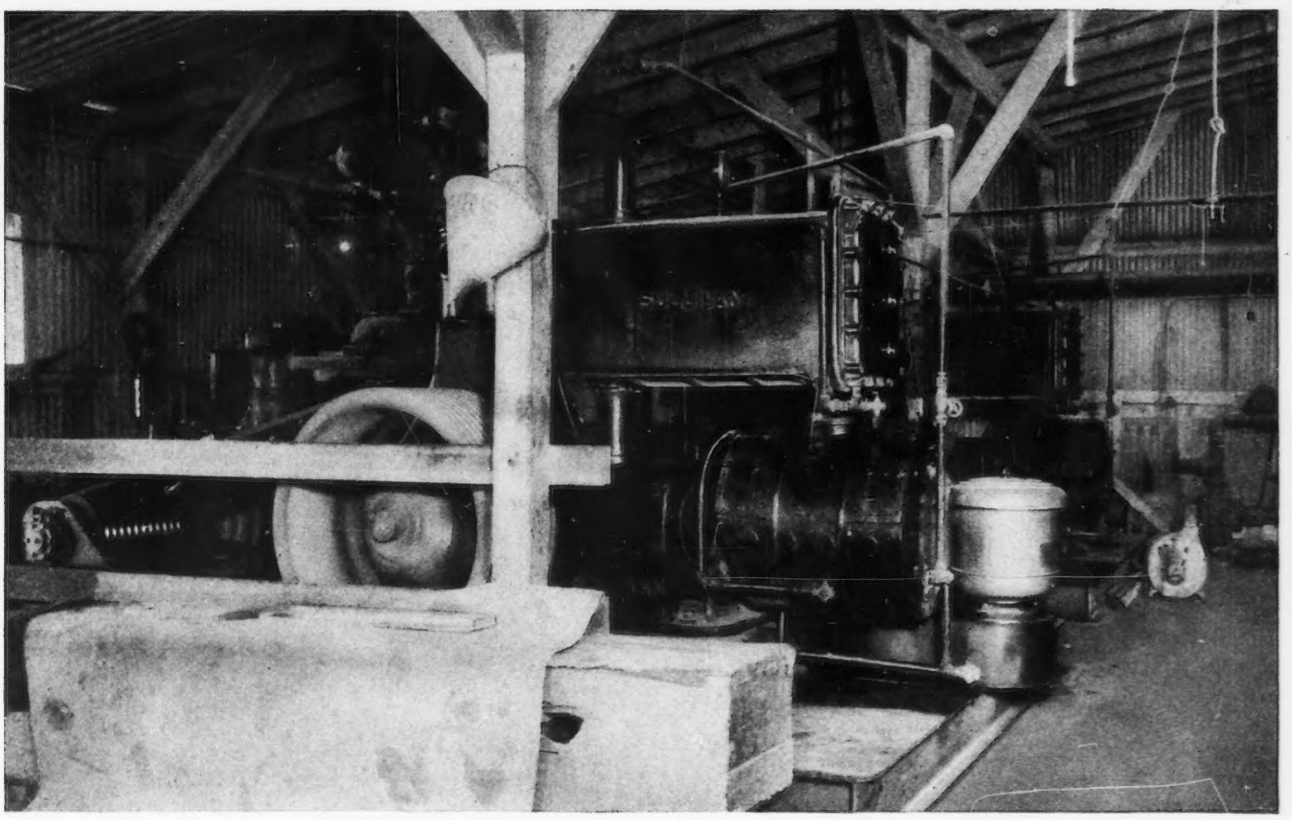

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FRED ALLEN in a full-hour program every Wednesday night, CBS, 9:00 E.S.T., 8:00 C.S.T., 10:00 M.S.T., 9:00 P.S.T.

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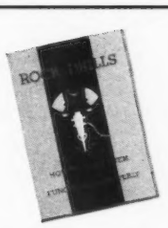

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GIVING continuous, efficient performance, these Sullivan compressors operate at peak efficiency . . . deliver full pressure at low power cost. The lubricant responsible for keeping these compressors clean and effective . . . is *Texaco.*

Texaco Alcaid, Algol and *Ursa Oils* are highly stable and resist carbon formation. They keep valves operating properly, lines and ports clear, rings free.

Trained lubrication engineers will gladly cooperate in making savings with *Texaco Alcaid, Algol* or *Ursa Oils* in your compressors. Phone the nearest of more than 2300 Texaco warehousing points in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York, N. Y.

TEXACO ALCAID, ALGOL, AND URSA OILS

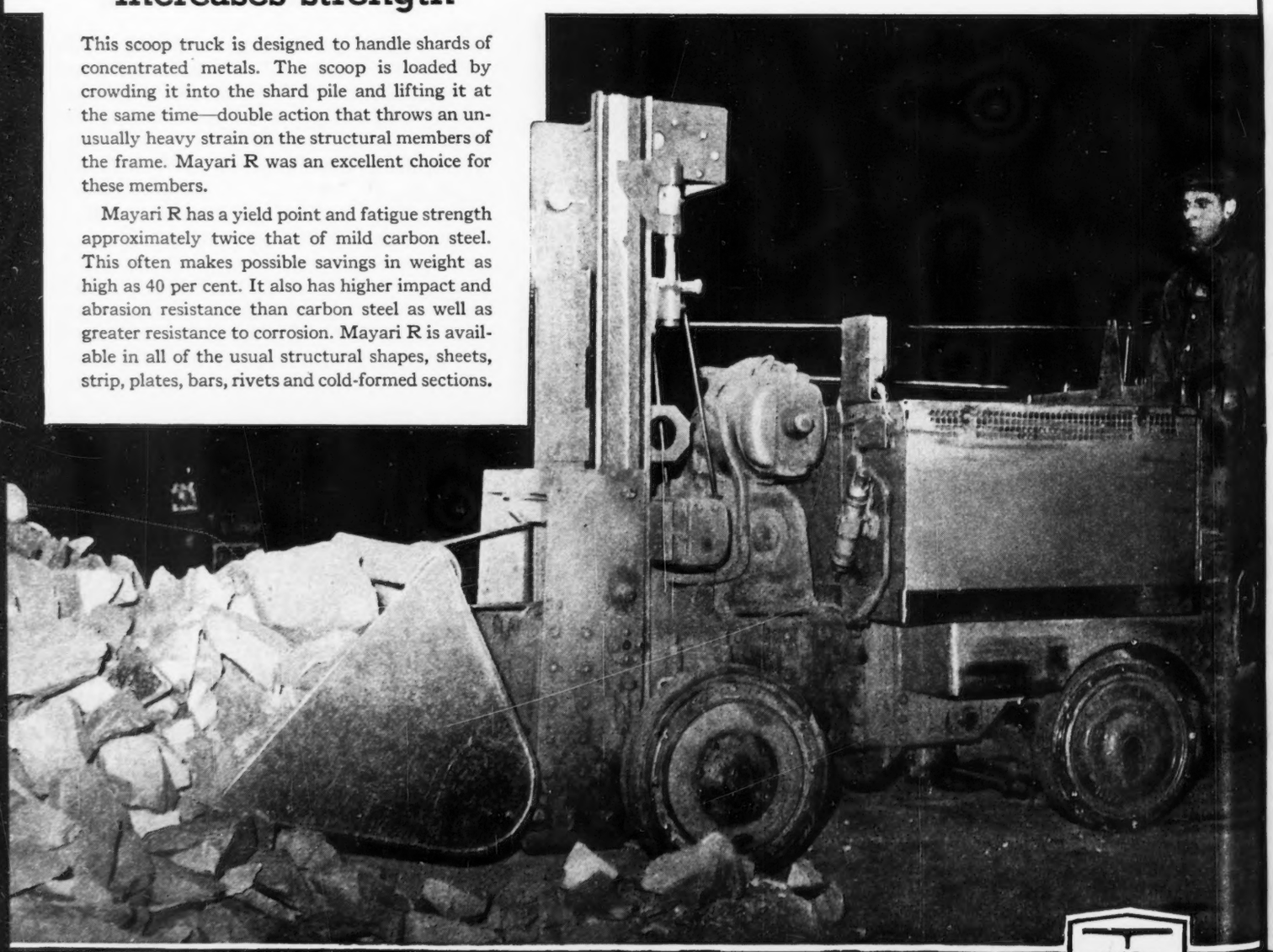
Bethlehem Materials

cut operating costs

Mayari R saves weight increases strength

This scoop truck is designed to handle shards of concentrated metals. The scoop is loaded by crowding it into the shard pile and lifting it at the same time—double action that throws an unusually heavy strain on the structural members of the frame. Mayari R was an excellent choice for these members.

Mayari R has a yield point and fatigue strength approximately twice that of mild carbon steel. This often makes possible savings in weight as high as 40 per cent. It also has higher impact and abrasion resistance than carbon steel as well as greater resistance to corrosion. Mayari R is available in all of the usual structural shapes, sheets, strip, plates, bars, rivets and cold-formed sections.



Bethlehem Products for the Mining Industry: Rails . . . Steel Ties . . . Frogs, Switches, Switch Stands, Turnouts and Special Trackwork . . . Track Bolts, Nuts, Spikes . . . Mine Cars . . . Wheels, Axles . . . Bars, Plates, Structural Shapes . . . Steel Construction . . . Steel Timbering . . . Pipe, Boiler Tubes . . . Galvanized Roofing, Siding . . . Wire, Nails, Fence . . . Wire Rope, Strand . . . Drill Steel . . . Forgings . . . Castings . . . Pig Iron.

BETHLEHEM STEEL

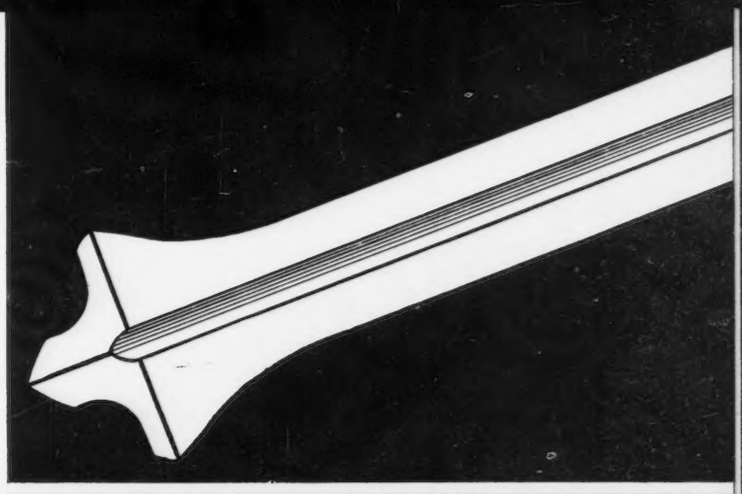
Smoother, better centered hole because it's rolled-in

Bethlehem Superior Hollow Drill Steel has a well-centered hole without pits or hairline cracks—smooth inner walls that mean longer drill life.

Here's the reason for this accurate centering:

Bethlehem uses precision methods in rolling Bethlehem Superior Hollow Drill Steel. First, a billet is drilled and a steel core is driven in this hole. Next, the billet and core are rolled down to size. The core is withdrawn, leaving a full length section of drill steel whose inner wall has no irregularities to give fatigue stresses a foothold.

The uniform quality of Superior Hollow Drill Steel has won the approval of operators in every major mining area. Wherever it is used it sets new high standards of performance.

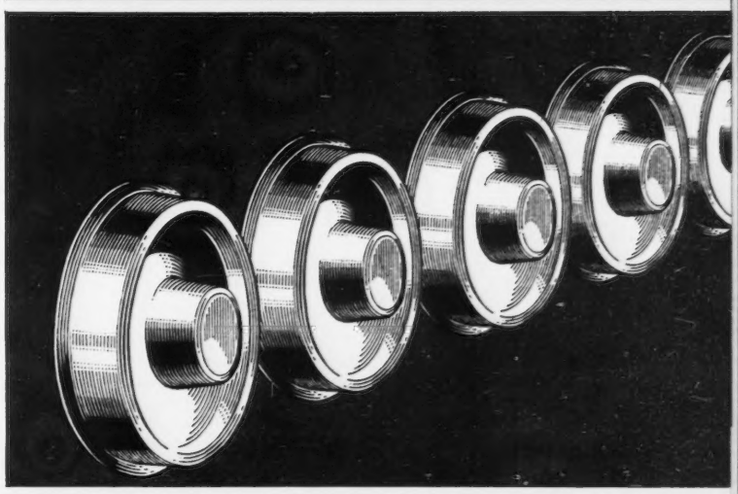


Bethlehem mine car wheels are forged to last

Bethlehem-Forged-Steel mine car wheels have rolled up an impressive record on all types of mine cars. During the 14 years these wheels have been on the market not one has ever chipped, cracked or broken in service.

Wherever these rugged wheels have been used they have eliminated costly wheel-failure hold-ups. They wear well. Any flat spots caused by irregular track, tend to "iron out" in service so that the wheels maintain nearly perfect treads.

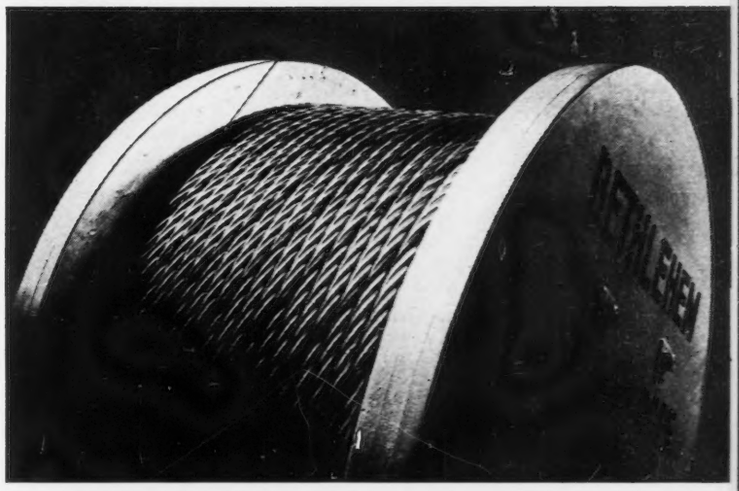
Bethlehem-Forged-Steel wheels meet A.M.C. Standard tread contour. They are interchangeable and can be used to replace any anti-friction-bearing type of wheel.



Bethlehem Formset Ropes relaxed for longer life

Bethlehem Formset Ropes are relaxed, free from internal stresses that shorten service life. These preformed ropes wind smoother on the drums and are easier to thread through sheaves. Rope distortion and wickering are reduced. This protects the rope from multiplied wire breakage and the operator's hands from possible injury.

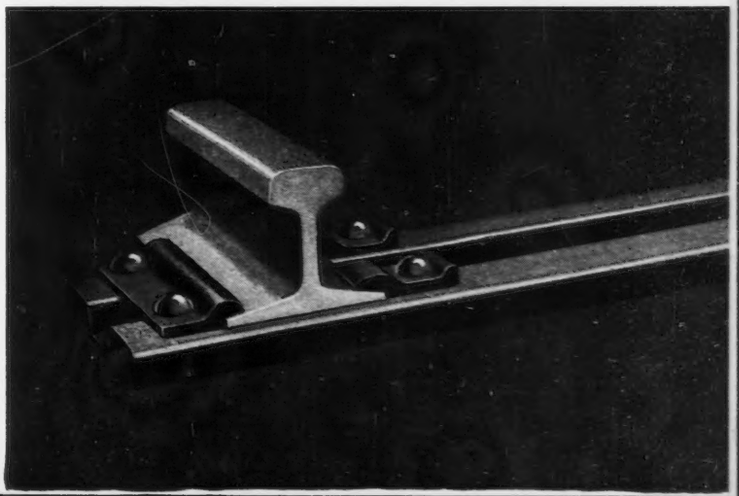
Bethlehem Formset Wire Rope is available in all constructions, all six standard grades of steel, three types of cores and in a full range of sizes.



There's 10 times the service in Bethlehem Mine Ties

While the average wood tie can rarely be re-laid more than four times, Bethlehem Steel Mine Ties can be re-laid as many as 40 times. A further saving will be found in the comparison of relaying costs: seven cents to relay a Bethlehem Steel Mine Tie against a cost of approximately fourteen cents for a wood tie.

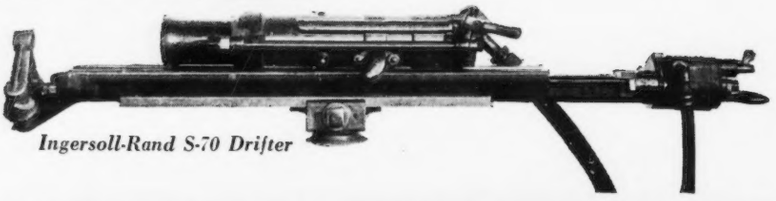
Among the other advantages of Bethlehem Steel Mine Ties are: Elimination of fire hazard; elimination of spikes—a single hammer blow locks each clip of the tie securely to the rail: elimination of gage rods—the tie itself holds the track in perfect alignment at all times.



BETHLEHEM STEEL COMPANY

TOUGHER drifters, FASTER drilling...

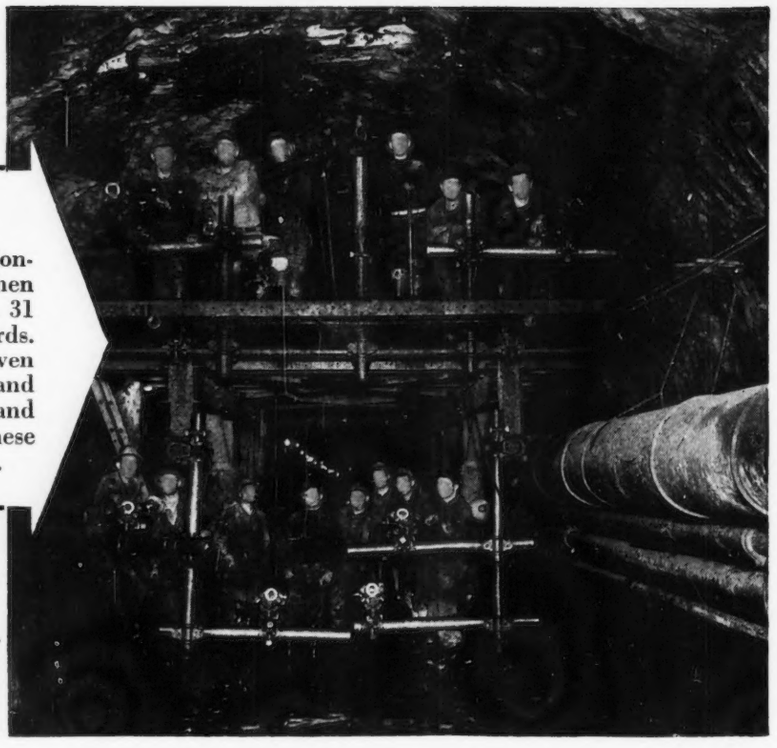
with NICKEL ALLOY STEELS



Ingersoll-Rand S-70 Drifter

1. CRIPPLE CREEK

Carlton Drainage Tunnel crews hung up monthly progress records of 1,735 and 1,879 feet through solid granite. Five Ingersoll-Rand DA-35 drifters, grouped on a jumbo, are boring this difficult job. 31% of all the parts of these drills are made of tough Nickel alloy steels.



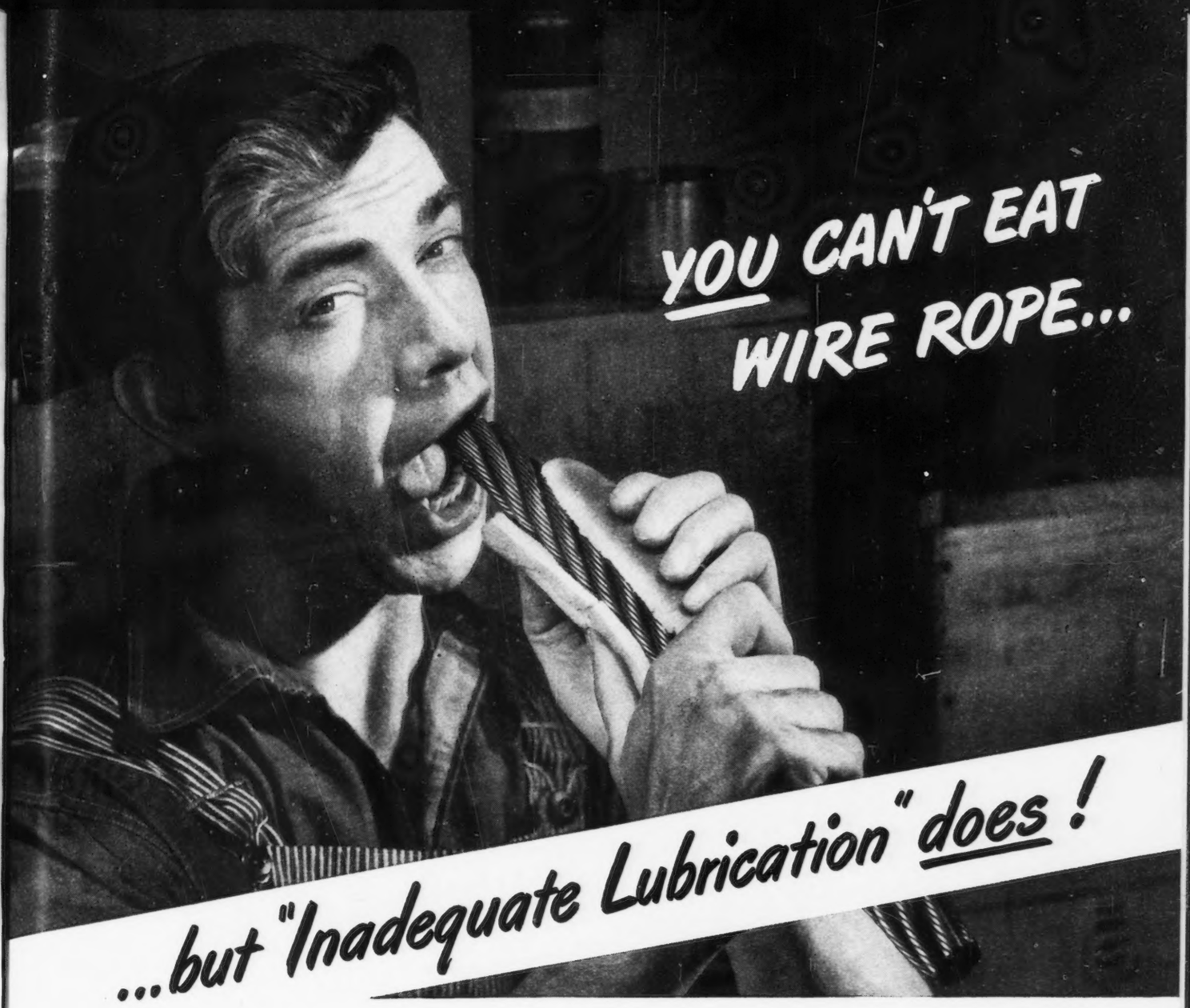
2. NEW YORK

Delaware Aqueduct crews of the Walsh Construction Company pushed 1,619, 1,862 and then 2,019 feet through shale and sandstone in 31 consecutive working days—to set new records. Two jumbos were used, each mounting seven Ingersoll-Rand S-70 drifters. To withstand shock loads and fatigue strains, Ingersoll-Rand makes one out of every three parts of these drills from high strength Nickel alloy steels.

Whether your problem is to move more tonnage or whittle down per-ton costs, steels strengthened and toughened with Nickel can help you. You avoid costly breakdowns by specifying appropriate Nickel steels in new equipment or replacement parts. For practical answers to your metal problems, address:

THE INTERNATIONAL NICKEL COMPANY, INC.

67 WALL STREET
NEW YORK, N. Y.



Perhaps you never thought of lubrication in just this way — but picture to yourself thousands of tiny "bearings" sliding and pressing against each other. Naturally, they must be lubricated — and naturally you'll see that they are lubricated in your wire ropes — when you realize what it means in dollars and cents.

A proper wire rope lubricant regularly applied to the rope on the job, forms a protective coating that keeps those thousands of "bearings" operating with minimum friction. The result: — Wire fatigue and corrosion checked; more uniform wear; longer rope life.

Be sure your lubricant is the *right* one, that you are applying it properly and with sufficient frequency.

JOHN A. ROEBLING'S SONS CO.
Trenton, N. J. *Branches in Principal Cities*

CORRECT LUBRICATION:

1. *Reduces Rope Wear*
2. *Prevents Corrosion*
3. *Prolongs Rope Life*
4. *Lowers Operating Cost*
5. *Provides Greater Safety*

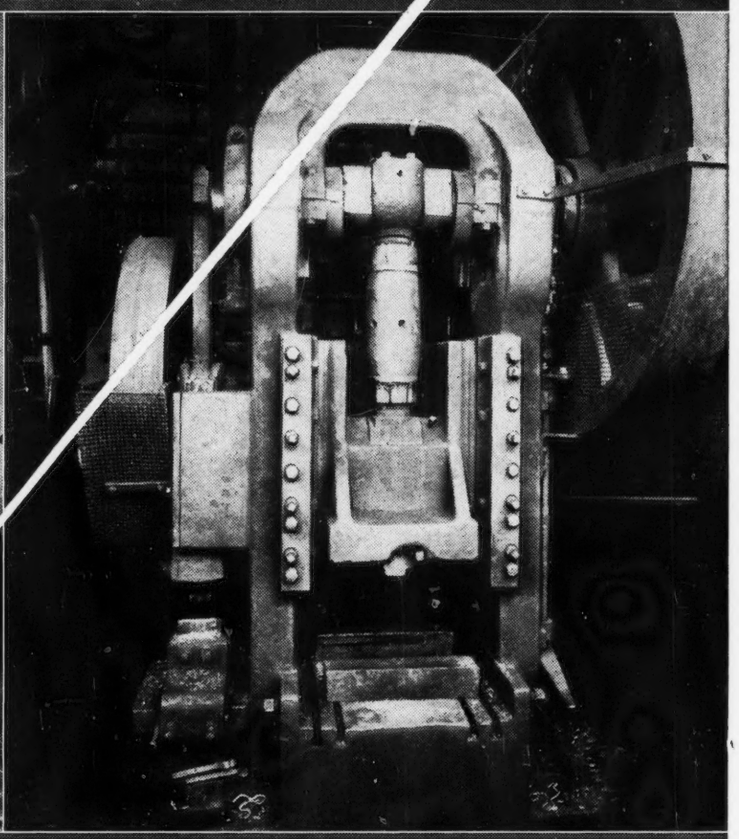
This advertisement is published in the interest of all wire rope users to help them obtain greater safety, service and efficiency from their wire rope.

ROEBLING

JAR *Wire Rope*

Ask about **ROEBLING "BLUE CENTER" WIRE ROPE** *... either preformed or standard*

FROM THIS — TO THIS



IN 46 HOURS!

Thanks to Anaconda 997 Low Fuming Welding Rod

WHEN the Hebeler Welding Company of Buffalo, New York, were called in on this emergency job, they took one look at the fractured 4½-ton punch press; promptly recommended repair welding with Anaconda 997 Low Fuming Rod . . . a high strength, tough weld metal with low fuming characteristics.

The job consumed 160 pounds of filler rod and 1,600 feet of both oxygen and acetylene. Chipping, preheating with natural gas and compressed air and other preparation required 35 hours; welding, 11 hours. The result was a strong sound weld and a happy production manager, for the downtime loss was only a fraction of what he expected.

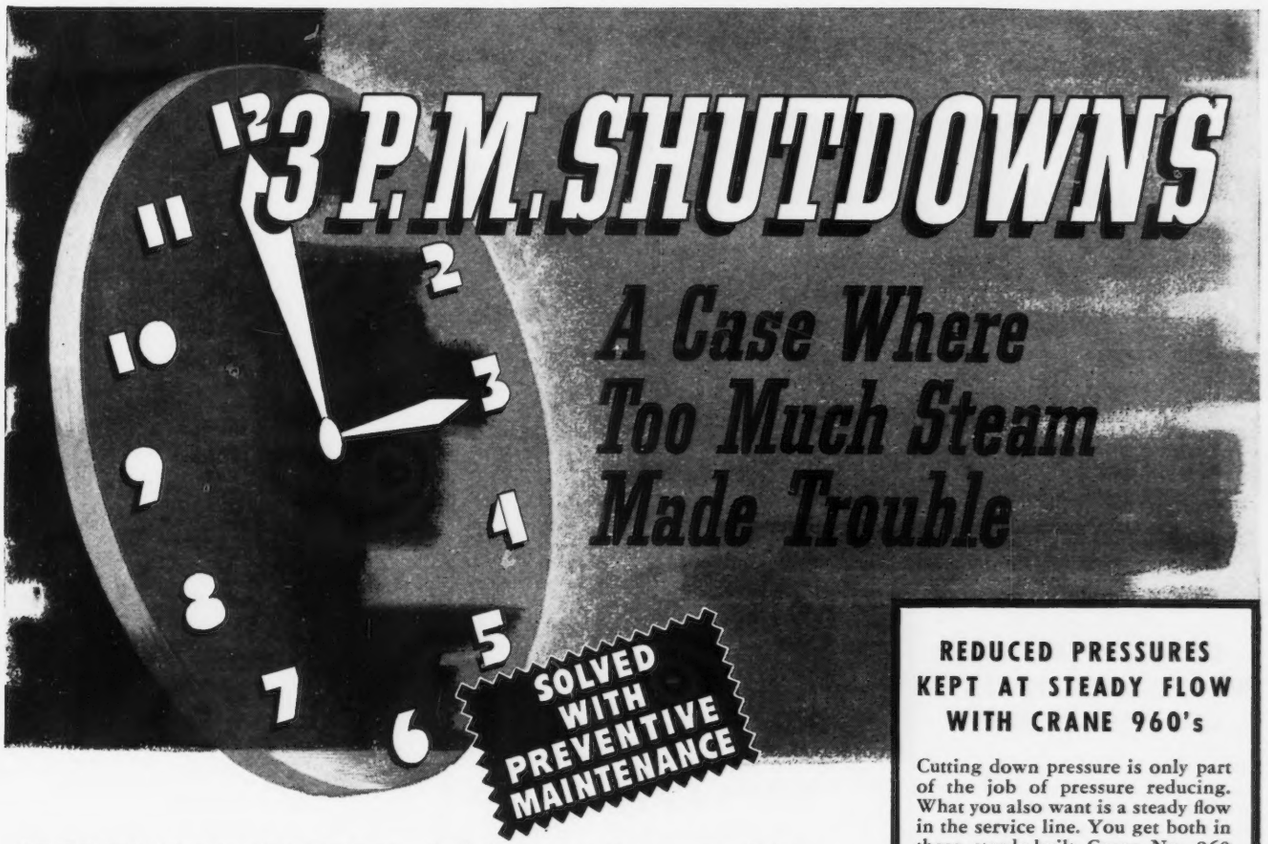
Next time you're faced with a similar emergency, bear this story in mind. Anaconda Rods are produced in an extensive line of alloys for all kinds of welding. You can obtain them from your jobber. 40119

ANACONDA from mine to consumer

Anaconda Welding Rods

THE AMERICAN BRASS COMPANY, General Offices: Waterbury, Connecticut

In Canada: Anaconda American Brass Ltd., New Toronto, Ont. • Subsidiary of Anaconda Copper Mining Company



"YOU'LL have to shut down at three today," the Superintendent of a northwestern wood-working plant said to his shop foreman. ". . . Kiln's tied up again with heating trouble!"

The plant was swamped with orders—like many another shop today. And repeated valve trouble in the steam line at the kiln meant falling farther behind on deliveries.

Preventive Maintenance was the only answer. For it's the only way of solving piping problems permanently. Yet, Preventive Maintenance is a simple technique—just a matter of *being sure* the installation is right, and the valves and fittings the best for service conditions.

The Superintendent saw the waste in ordinary repair—he called in H. E. O., the Crane Man. His wide experience would help to remedy the trouble quickly and surely.

Here's what the two men found: Steam was piped from the boiler with a four-inch line equipped with a four-inch pressure-reducing valve. And there was the source of the trouble! The valve was much too large. It couldn't operate properly at the low pressure setting required. Severe wire-drawing cut the seat and disc. The valve leaked—pressure went up—the kiln temperature couldn't be controlled.

Preventive Maintenance counseled replacement with a two-inch pressure regulator. It would give ample steam for heating the kiln. It would give finer control without restricting operation of the automatic valve mechanism. A Crane No. 960 brass regulator was put in the line.

Results: No more interruption of kiln operation; no more shop time lost for lack of material. Another plant superintendent knows the value of Preventive Maintenance. Also knows the Crane Man can help him get most for piping maintenance dollars. Because Crane is not only the source of valves and fittings for every service, but of accurate information on their proper application as well.

This case is based on the personal experience of H. E. O., a Crane Representative in the St. Paul Branch.

REDUCED PRESSURES KEPT AT STEADY FLOW WITH CRANE 960's

Cutting down pressure is only part of the job of pressure reducing. What you also want is a steady flow in the service line. You get both in these sturdy-built Crane No. 960 Brass Pressure Regulators for steam or air.

The 960 is ideal for Preventive Maintenance on modern process lines—on vulcanizers, cookers, driers, paper machines, air tools, air blasts, in heating systems.

Unlike ordinary reducing valves, the Crane 960 maintains reduced pressure at the point desired regardless of how much steam or air is being used. It will not permit pressure build-up when service line is idle.

Crane 960's are available for reduced pressure ranges of 5 to 30 pounds and 31 to 200 pounds. Operation is simple; ready accessibility permits easy inspection and servicing. In 6 sizes up to 2". Page 415 of your Crane No. 52 Catalog gives complete specifications.

1940 OUR 85th YEAR

CRANE

CRANE CO., GENERAL OFFICES: 836 S. MICHIGAN AVE., CHICAGO

VALVES • FITTINGS • PIPE
PLUMBING • HEATING • PUMPS

NATION-WIDE SERVICE THROUGH BRANCHES AND WHOLESALERS IN ALL MARKETS

WE USE SKF BEARINGS

CHICAGO PNEUMATIC TOOL CO.

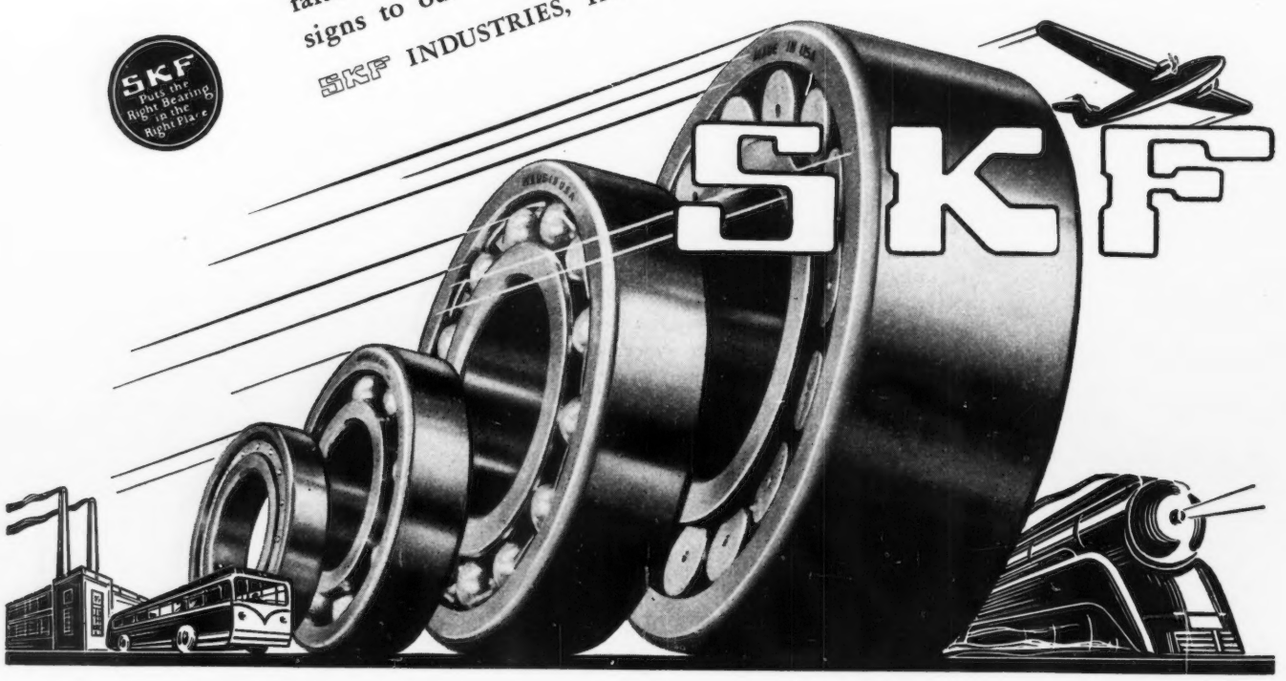
A MODERN COMPRESSOR...*it's* SKF-equipped

There's a big package of SKF economy, durability, compactness, easy installation, smoothness, quietness, and flexibility that comes with this Type "Y" Compressor. For this "package" type of unit, available in capacities of 300 to 800 cubic feet per minute at 80-125 pounds pressure, has three SKF Spherical Roller Bearings on its main locations.

Self-contained and needing no fussy adjustments, SKF Bearings lower maintenance costs . . . serve faithfully throughout machine life. Send *your* designs to our engineers . . . TODAY. 4694

SKF INDUSTRIES, INC., PHILADELPHIA, PENNA.

SKF Puts the Right Bearing in the Right Place



AN OPEN LETTER...

HAZARD WIRE ROPE DIVISION
OF
AMERICAN CHAIN & CABLE COMPANY, INC.
WILKES BARRE, PA.

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PITTSBURGH
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DISTRICT OFFICES
FORT WORTH, TEX.
DENVER
TACOMA
LOS ANGELES
SAN FRANCISCO

GENERAL OFFICE AND WORKS
WILKES BARRE, PA.

To Wire Rope Users:

If there be one thing in which we have more pride than in our product—it is our customers.

Their faith in Hazard Wire Rope—their confidence in Hazard counsel—their belief that Hazard prices are fair and assure obtaining more than average service return for their money—continuously spur our organization to develop an even finer wire rope rather than to produce the greatest volume.

We do not make as much wire rope as some manufacturers. What we make we try to make well. That some customers have bought Hazard Wire Rope for 30 years—40 years—even 50 years—encourages us to hope that we have not labored in vain.

To merit such loyalty is our purpose for today and the future as it has been in the past.

In saying this, we believe we speak for every member of our organization.

Vice President

ACCO

HAZARD LAY-SET
Preformed

Correct rope reeving saves wire rope dollars . .

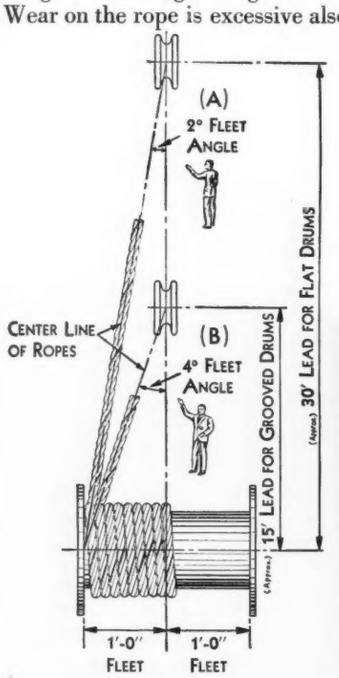
This is No. 6 in a series of informative articles for wire rope users prepared by the Macwhyte Wire Rope Company.

Avoid excessive fleet angles on your equipment

The fleet angle is that angle included between lines drawn from the center of the drum, and from the flange of the drum, to the lead (first) sheave. Both (a) and (b) below are illustrations of fleet angles.

Wire rope is often seriously damaged when this fleet angle is excessive. Side wear and severe scuffing result. Often individual wires become misplaced, bruised, crushed.

Grooved drums are damaged, too, by wide fleet angles. Ropes wear against the groove walls, grinding them down. Wear on the rope is excessive also.



WHAT TO DO

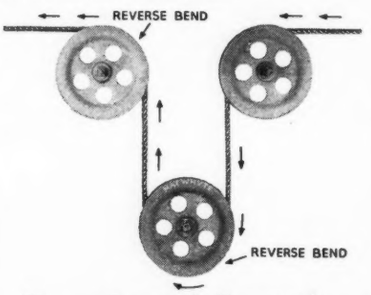
Check the fleet angles on your equipment. Keep the angle as small as possible. A fleet angle between 1° and 1½° is ideal. Fleet angles as low as ½° and up to 2° for flat faced drums and 4° for grooved drums are permissible for most hoisting equipment. If the fleet angle exceeds these values, then look out for excessive drum wear or poor spooling.

Guard against reverse bends

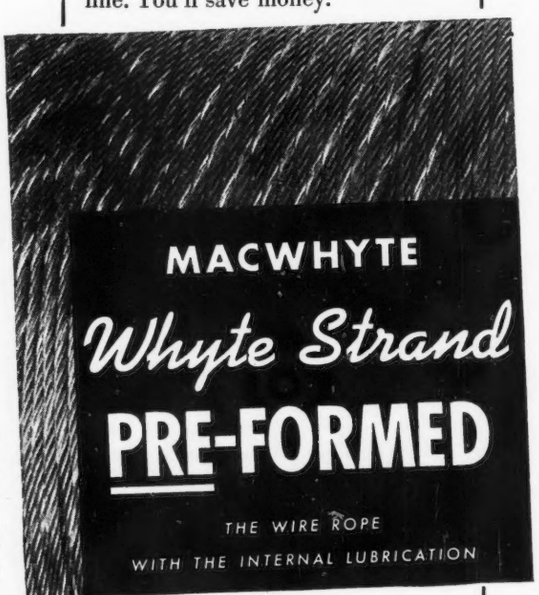
Years of experience and many tests have proved that reverse bending and excessive wire fatigue reduces rope life as much as 50%.

Where reverse bending cannot be eliminated, use the largest sheaves possible and place them as far apart as you can. By getting the MAXIMUM distance between reverse bends, you reduce fatigue—provide for longer service.

Keep sheaves aligned, too. Countless rope dollars have also been lost because sheaves are out of line.



You can detect misalignment by uneven groove wear. Keep sheaves in line. You'll save money.



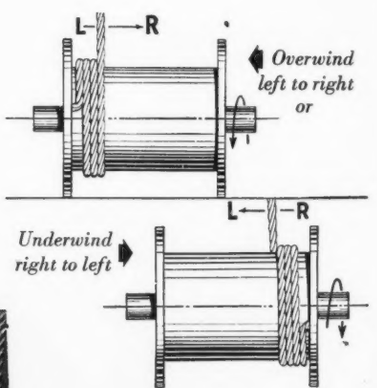
MACWHYTE COMPANY
2940 Fourteenth Avenue, Kenosha, Wisconsin
Manufacturers of rope wire—braided wire rope slings—Monel Metal and Stainless Steel wire rope—aircraft cable, tie-rods, and 'Safe-Lock' terminals for aircraft—and wire ropes for all requirements.
New York . . . Pittsburgh . . . Chicago . . . Ft. Worth . . . Portland . . . Seattle . . . San Francisco
DISTRIBUTORS THROUGHOUT THE U. S. A.

Steer clear of slip-shod spooling

Make sure the rope is wound on your drum in the *correct direction.* Rope wraps will then be close to each other and in line. Rope wear will be reduced to a minimum.

If rope is started in the *wrong direction,* however, uneven winding will result. Ropes cross and crush each other, causing a "burning" and scuffing of wires.

The following drawings show correct spooling for right lay rope when observer stands behind drum looking toward the direction of rope travel:



SEVERAL LAYER WINDING

There is usually considerable wear and scuffing against drum flanges when ropes change from one layer to the next. You can offset this condition in two different ways:

FIRST, and most effective, use rope of such length that there will be only one layer of winding; or when this is not possible . . .

SECOND, use a rope of MORE than sufficient length so that a short section can be cut from the drum end occasionally. This moves up the point of wear.

Previous articles in this series are available on request on your company letterhead, also G-13 general wire rope catalog containing much helpful information.

NO. 485

ELEVATOR BUCKETS

"Continuous" type buckets are available in malleable iron and steel in a number of styles, with different shapes, depending upon material to be handled and angle at which the elevator stands.

that Last Longer!

● Use the correct bucket for the job. The Link-Belt line includes steel, malleable iron and Promal buckets of suitable size and type to meet any requirement. They are recognized as the standard for toughness—smooth, uniform construction and correct design . . . features that assure proper filling, free and clean discharge and long life.

Link-Belt malleable iron buckets are made of the same metal from which our high-grade malleable iron chains are cast. Promal buckets are stronger than buckets of malleable iron and offer a greater resistance to abrasive wear. Longer life in hard use and under severe abrasive conditions, quickly justifies their slightly higher price.

Fabricated buckets include seamless, welded and riveted construction, using metals and metal treatments which best fit these buckets for the work they are expected to perform.

Large stocks are carried at all Link-Belt plants and warehouses and by many distributors. Specially made buckets can also be supplied . . . galvanized, bronze, aluminum, and baked-enamel finish. General Catalog No. 800 contains complete engineering and descriptive data about operation and design of bucket elevators. If you don't have a copy, write for one today.

Style "A". Cast in malleable iron and Promal. This is the standard form and the most generally used for handling cement, coal, phosphate, pulp, etc. Style "AA" is similar in shape but has heavy reinforced front edges and corners which give increased life in handling material of an abrasive nature.

Style "B" malleable iron bucket is favored for use in inclined elevators and for handling coarsely broken materials.

Style "C" malleable iron bucket is designed for handling clay, sugar, finely pulverized ores and such other materials as tend to stick or pack.

Style "AA-RB" bucket for heavy service. Available in both malleable iron and Promal. The back is made twice the usual thickness of the standard "AA" bucket. The heavy lip is continued around the ends of bucket and vertical ribs reinforce the front. A most substantial and satisfactory bucket where severe service is encountered.

Corrugated seamless steel bucket. Made of one-piece pressed steel, with round corners and bottom; no laps, no rivets or seams. This bucket will stand more hard usage and is the strongest of any seamless bucket of the same gauge and size.

Super-Salem steel elevator bucket costs no more than the standard Salem. It is reinforced at digging lip, front corners and along back. Very strong and offers super-resistance to abrasive wear. The extra strength is obtained without increase in bucket weight. Numerous other Link-Belt steel buckets of suitable designs for handling grain, are available.

LINK-BELT COMPANY

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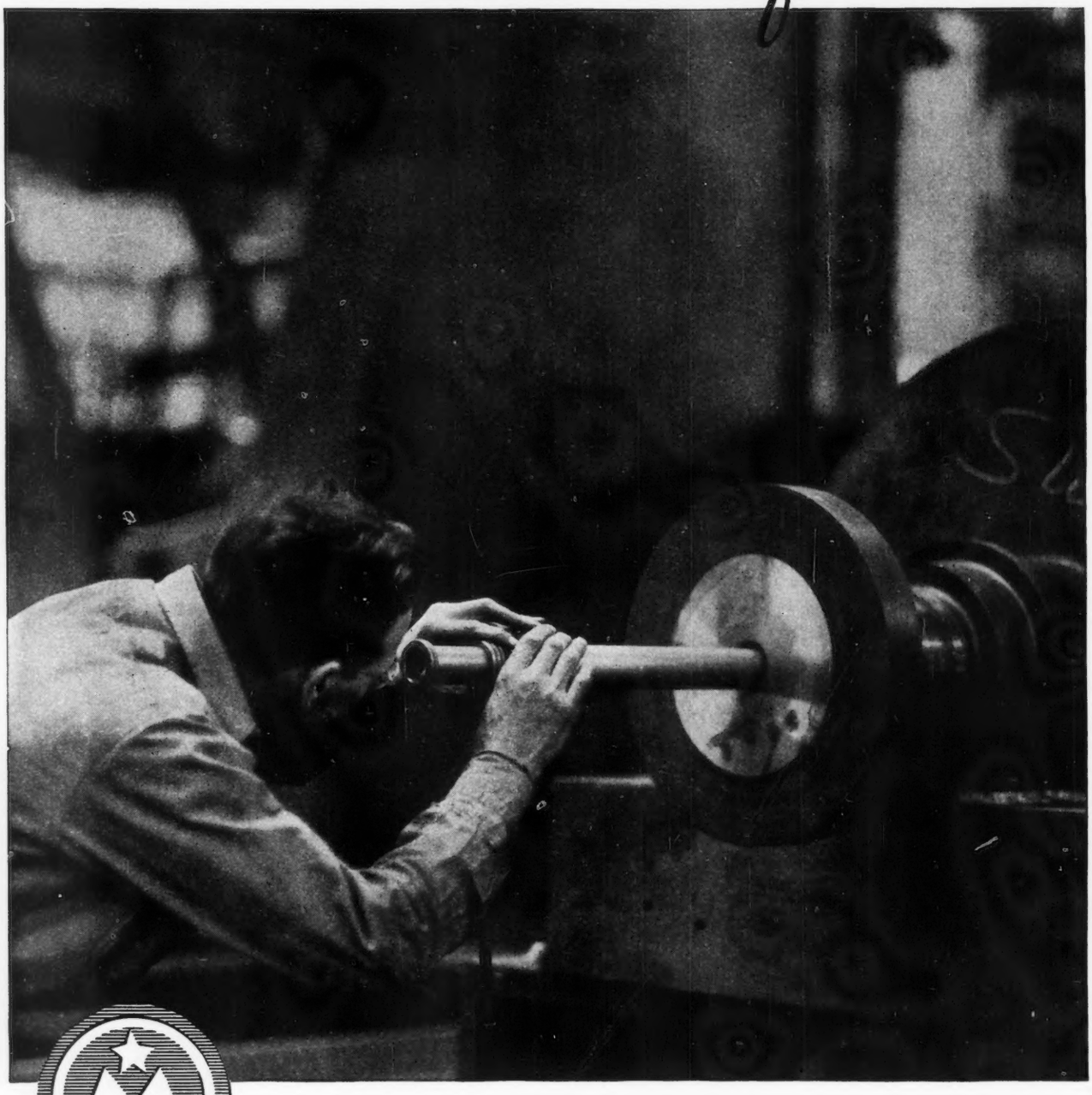
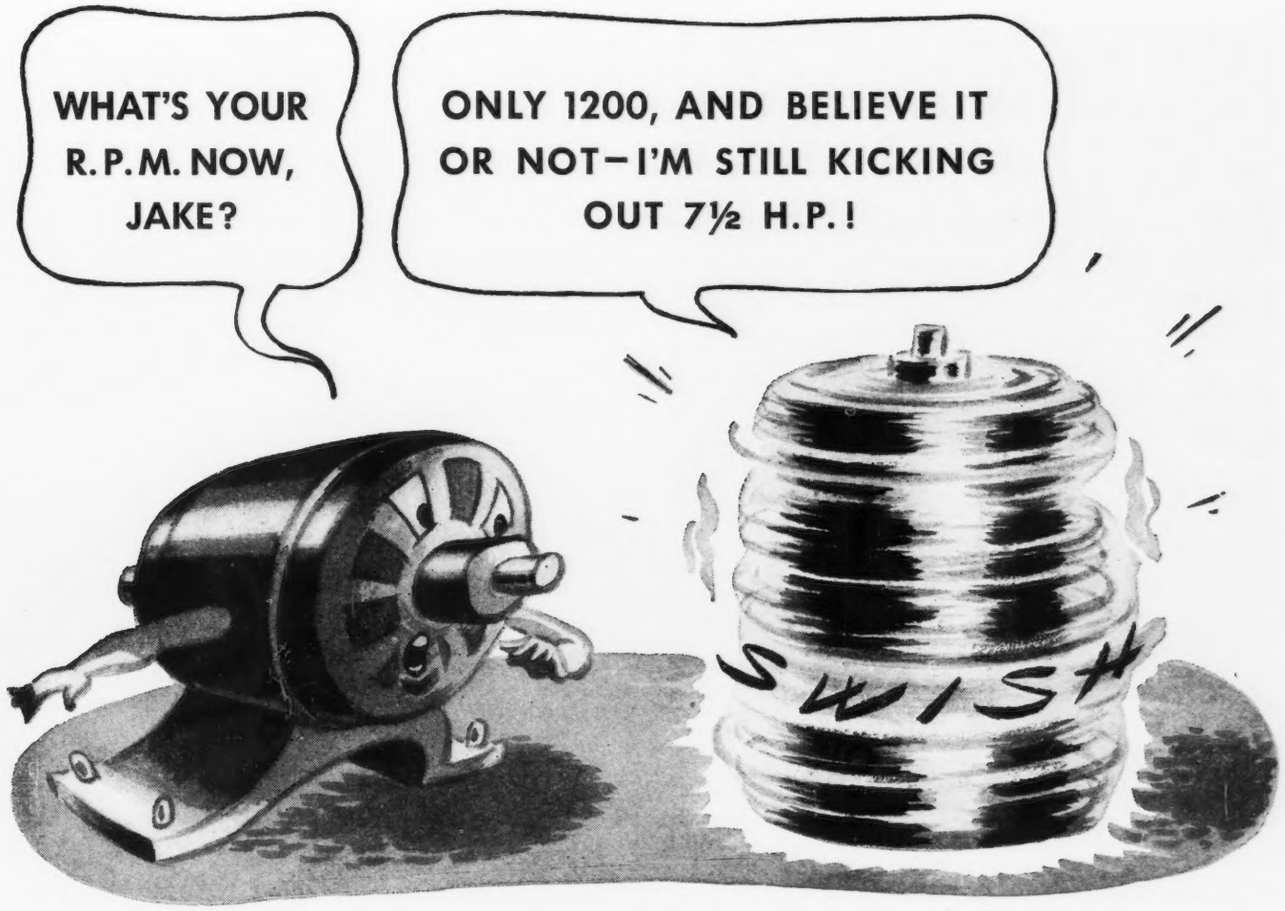
MIDVALE *Craftsmen*



PRECISION today is as vital in big things as in little. In some ways more vital—as its lack can be more costly. Large moving parts require rigid inspection that is literally microscopic—and Midvale experience, equipment and men know how to produce just this.

THE MIDVALE COMPANY • NICETOWN • PHILADELPHIA, PA.

OFFICES: ***New York • Chicago • Pittsburgh • Washington • Cleveland • San Francisco***



Space factor of Fiberglas* Insulation permitted same H. P. at Fewer R. P. M.

A BROOKLYN, N. Y. manufacturer of fine furniture had three motors side-by-side, operating a 3-drum sander-machine. They were 7½ horsepower A. C. jobs, each turning over 1800 r.p.m.

The manufacturer wanted to reduce the r.p.m. of his motors, so that he could change from belted drive to direct drive. The obvious way to do this would be to put in a slower motor with a larger frame size.

But there were only ⅛ inch clearances between the motor frames!

So, as a test case, he decided to rewire *one* of these motors to run slower. Fiberglas Electrical Insulation was used because its *greater* space factor permitted the additional windings required. This slowed the motor down to 1200 r.p.m., but still allowed it to deliver its full rated horsepower.

That was 15 months ago and not one penny's worth of maintenance has been spent on the test motor, which operates as much as 20 hours a day.

No wonder the manufacturer has decided to rewire the other two sander-machine motors with Fiberglas!

What This Means To You

There are two other variations on this small-motor trick of getting the same H. P. at lower r.p.m. You can get *more* horsepower out of your cotton insulated motors *without* increasing frame size by substituting Fiberglas Insulation, thereby allowing operation at higher temperatures. And you can get *more* horsepower *without* increasing weight.

Or you can get the *same* horsepower you have now by this method . . . in motors that are both smaller *and* lighter.

How To Go About It

Write today for Fiberglas Electrical Engineering Data. Find out why insulation made from this glass in fibrous form has superior electrical insulating properties, how it withstands high temperatures, how it resists acids, oils, and chemicals, how its many other advantages can add up to important maintenance savings for you. Pick the toughest job you have. Put Fiberglas insulation in *that* spot . . . and see for yourself! Owens-Corning Fiberglas Corporation, Toledo, Ohio. In Canada: Fiberglas Canada, Ltd., Oshawa, Ontario.

OWENS-CORNING

FIBERGLAS*

*T. M. Reg. U. S. Pat. Off.

TOLEDO, OHIO

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DO YOU KNOW THIS ABOUT *detachable bit grinding?*

IN at least one important respect, grinding a detachable bit is like grinding anything else . . . for best results you've got to use the *right* grinding wheel. And if you do use the right grinding wheel you'll get the lowest cost per grind . . . and the most work from each resharpened bit.

That's the big reason why so many operators are using Aloxite Brand Aluminum Oxide Wheels. They help you realize *every* advantage and economy of detachable bits! These long-lived wheels are built to hold their shape, and to cut fast, free and cool. They assure you accurate gauge and form . . . longer tool life between grinds . . . reduced grinding time . . . and lower cost per grind.

Aloxite Brand Aluminum Oxide Wheels are available in the correct grit and bond for every requirement. Remember the name "Aloxite Brand" when you order.

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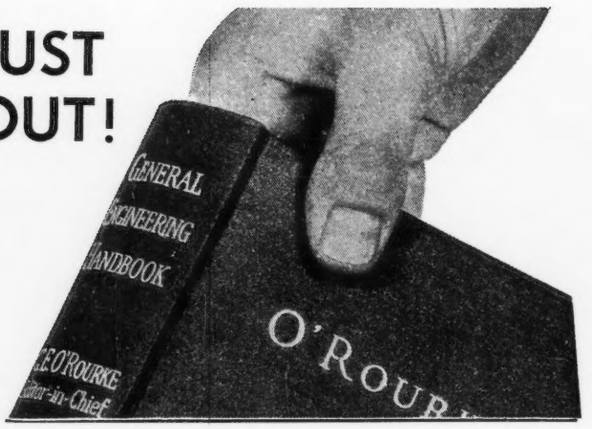
JUST OUT!



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You have in this book what engineers have asked for time and time again—one handbook that embodies the most fundamental and frequently useful data of all engineering—1120 pages of practical, up-to-date information, reference data, specific facts, definite methods, essential formulas, covering civil engineering, mechanical engineering, and electrical engineering. You secure in this handbook the engineering information you constantly want in the form in which you want it and can use it—one handy book, clear, concise, complete, convenient.

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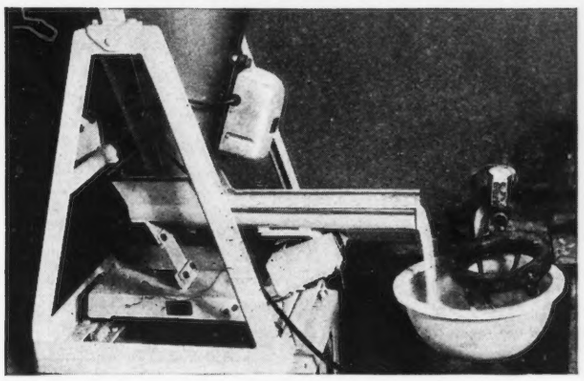

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"PULSATING MAGNET" VIBRATOR

on that stubborn hopper to keep its contents agitated—and—regulate its discharge by a

"VIBRA-FLOW" FEEDER

with its rheostat control of rate of flow

Write for catalog showing large and small models of both

SYNTRON CO., 510 Lexington Ave., Homer City, Pa.

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We are proud of the fact that *more than 90% of the engineers who request working samples of Greene, Tweed Packings become permanent users.* Such remarkable approval by these engineers who have tested our packings under every conceivable condition should convince you that you cannot afford to delay in making your own tests. If you want longer packing life, less wear and less frequent shut-downs for repacking, send now for free working sample specifying size and service.

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Established 1863

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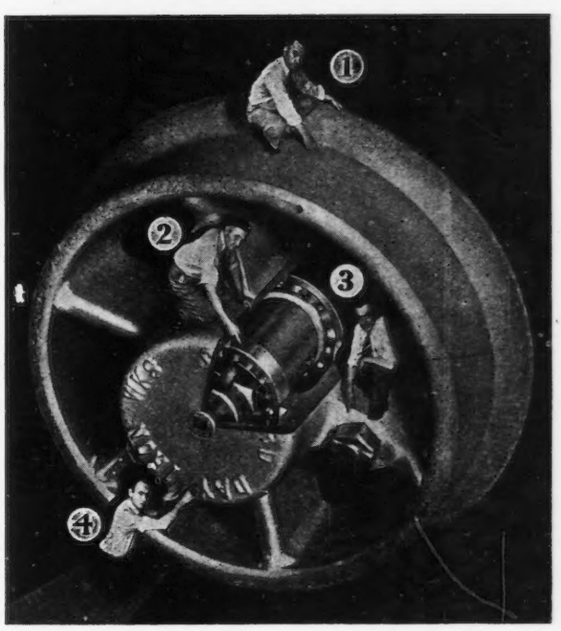
PACKING

FREE—

TRIAL OFFER

ON S-D "FLOATER" BALL BEARING WHEELS

Take advantage of our "Free Trial Offer" on S-D "Floater" Ball Bearing Wheels before you place an order for extra trucks. We want to prove to your own satisfaction, under existing conditions in your own plant, that S-D "Floaters" are the most satisfactory wheels you ever used. For service on tough jobs, S-D "Floaters" have stood the punching where all other wheels tried have failed. For economy, S-D "Floaters" practically eliminate maintenance costs. Lubrication saving is amazing, and covered by our written guarantee. You take no chances . . . bearings, wheel castings, and all truck parts positively guaranteed against wear and breakage in normal service. Write or wire now for FREE Trial Truck offer.



1—Deep Chilled treads . . . true shape . . . scientific contours. And, most important, S-D "Floaters" are annealed by Sanford-Day's Patented annealing process for uniform strength.

2—The S-D "Floater" Bearing. This unusual principle permits the bearings to automatically adjust themselves and prevents any possibility of damage by pinching.

3—Demountable, just like an automobile wheel, but easier. By simply removing the lock nuts, wheel may be slipped off axle, while bearings remain in place and in perfect adjustment on the axle. Nuts are protected from damage by wheel tread.

4—Solid closed hub . . . no loose caps to come off . . . no troublesome, projecting axles, nuts cotters or screws . . . no grease leakage.

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3120 DALE AVE., KNOXVILLE, TENNESSEE, U.S.A.

MINE CARS, ALL TYPES • TRAILERS • WHEELS • SHEAVES

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Assaying *Management* *Metallurgy*
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We sample properties and assay samples
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Examinations—assaying, analysis and metallurgical testing — ore,, concentrates and gold buying
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calls for operating efficiency all along the line. These specialists in various phases of mine operation can aid you materially in determining quick, economical solutions to your mining problems, that make for more efficient operations, resulting in lower costs and a consequent greater return on your investments. Consult them!

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Most accurately and economically tested for . . . with the

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Contracts undertaken at any place in the world for any purpose to any reasonable depth.

Manufacturers of Diamond Drill Machines and Equipment with capacities ranging from 100' to 3200' in depth; core sizes 7/8" diameter and over.

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"EX"—"AX"—"BX"—"NX" Sizes

SPRAGUE & HENWOOD, INC.
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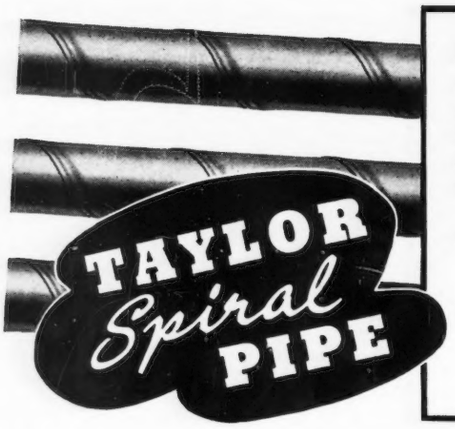

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● That's the real measure of pipe. In Taylor Spiral Pipe you get a light wall pipe, which, thanks to its spiral reinforcing seam, provides a resistance to bursting, collapsing and other stresses substantially greater than that of wrought pipe of heavier weight.

Cutting weight without sacrificing strength saves three ways: handling, shipping and installation. A triple play!

Joints, sizes, gauges, lengths and coatings for every mining service. Write for Catalog 404.

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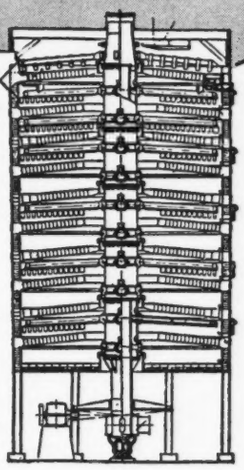
STEP UP NATIONAL DEFENSE PRODUCTION

SULFIDE ORES & CONCENTRATES
for
Iron Sulfide Zinc Sulfide
Copper Sulfide Molybdenum Sulfide



ZINC

COPPER

QUICKSILVER ORES

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The materials listed in the panels are a few of those vital for National Defense. For many years these have been processed in Nichols Herreshoff Multiple Hearth Furnaces. Now when speed is necessary, we can, because of our years of experience save you time and money in securing increased production.

Thousands of these furnaces are in use today. Being flexible in design, compact, requiring minimum floor space, having low power consumption and being simple to operate they offer an efficient and economical means of processing many materials.

Write for bulletin No. 206 — describing these furnaces.

NICHOLS
ENGINEERING & NERCO RESEARCH CORP.
60 WALL TOWER, NEW YORK, N. Y.
UNIVERSITY TOWER, MONTREAL, P. Q.

AMONG OVER 12,714 KEY MEN . . .

operating mining properties in the United States, 64 colonies, and foreign countries, it stands to reason that . . .

A Classified Advertisement in the Searchlight Section of the Engineering and Mining Journal can find those who need the surplus mining equipment or material you have for sale . . .

Because they buy and read the Engineering and Mining Journal as part of their professional equipment.

Departmental Advertising Staff
Engineering and Mining Journal
330 West 42nd Street, New York, N. Y.

G.N.S. No. 5 PINE OIL

LONG THE STANDARD FROTHING OIL

For Flotation

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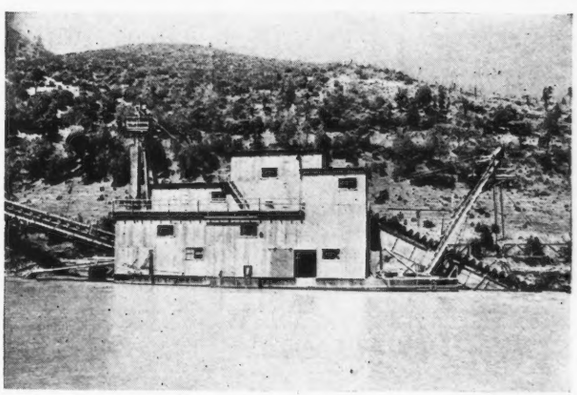

ANOTHER WASHINGTON DREDGE GOES INTO SUCCESSFUL OPERATION

Illustration shows Washington Dredge recently installed for the French Gulch Dredging Company, French Gulch, California.

WASHINGTON IRON WORKS
SEATTLE, WASHINGTON, U. S. A.

SEARCHLIGHT SECTION

GOOD USED EQUIPMENT

ROTARY KILNS: 8'x125', 6x120', 6x60'.
VIBRATING SCREENS: 5x10' 2-deck, Allis-Chalmers; 4x8' 2-deck, 3-deck Stephens-Adamson; 4x7' FB-4 Jeffrey-Traylor, 2-deck; 4x7' Leahy, 2-deck.
HARDINGE CONICAL BALL MILLS: 8'x30", with 175 H.P. 3/60/440 v. slip ring motor; also 5'x22", 7'x22", 8'x72".
ROD MILLS: 4x8', 6x12' Hardinge, straight side; 5x10', 5x12' Allis-Chalmers.
BALL MILLS: 2—5x10' Bonnot, steel lined with 150 H.P. motors.
TUBE MILLS: 3x12', 4x16', 5x22', 5x35'.
DIRECT HEAT ROTARY DRYERS: 4x30', 4x60', 4'6x50', 6x60', 8x60', 8'8x60', 8'8x85'.

Send for latest copy of "C-P News" listing hundreds of items of Jaw, Gyratory and Roll Crushers; Gyratory Finishing Crushers; Shovels, Cranes and Draglines; Locomotives; Vibrating Screens; Elevators; Conveyors; Pulverizers; Ball, Tube and Rod Mills; Air Compressors, Air Classifiers; Dorr Classifiers, etc.

CONSOLIDATED PRODUCTS CO., INC.
13-19 Park Row **New York, N. Y.**
Our Shops at Newark, N. J., cover eight acres.

3—Battery Type Locos. 4 ton, 24" ga.
1—Battery Charging Set
12—Dump Cars 1½ yd., 24" ga.
3—50 HP Electric Shaft Hoists
1¼, 1, ¾ yd. Owen, Williams Buckets
Compressors 250', 315', 531', 1500'
32 & 35 HP Gas Hoists
20, 30 ton Locomotive Cranes
¾, 1, 1¼ yd. Gas. Crawler Cranes
2—Model 20A Conway Muckers
Eimco Loaders Models 12B, 20, 21
1—Gardner-Denver Loader
5000 ft. 24" gauge Track
14S, 28S Concrete Mixers

J. T. WALSH
500 Brisbane Bldg. Buffalo, N. Y.

AIR COMPRESSORS:
(7) Steam 46 ft., 66 ft., 300 ft., 600 & 1000 ft.
(12) Belted, 360, 676, 870, 1300 ft.
(6) Electric, 1300, 1500, 1722, 2600, 5000 ft.
(14) Gasoline, 110, 160, 220, 310 & 370 ft.
6 Diesel 105, 315, 420, 603, 1000 & 1500 ft.

HYDRAULIC CARWHEEL PRESSES:
100 Ton, 150 Ton, 200 Ton, 300 & 400 Ton Caldwell-Niles-Wood-Watson Stillman

STORAGE BATTERY LOCOMOTIVES:
3 Mancha Little Trammers, 24 Ga.
3—3 ton Whitcomb, 24 Ga.
6—5 ton Whitcomb & Mancha 30 Ga.
4—4 ton Goodman, 36 Ga.
3—5 ton G.E. 36 Ga.
4—5 ton Mancha 36 Ga.
4—6 ton Goodman 36 Ga.
5—8 ton Baldwin-Westgh., 36 Ga.

TROLLEY LOCOMOTIVES:
2½ ton Westinghouse 24 Ga.
3—3 ton & 2—4 ton Goodman 36 Ga.
5—6 ton Baldwin-Westgh., 36 Ga. Comb.
4—6 ton Goodman 42 Ga. & 3 Goodman 36 Ga.
3—8 Ton Goodman 36 Ga.
4—6 ton Baldwin-Westgh., 42 Ga.
3—8 ton & 10 ton G.E., 42 Ga.

RUBBER CONVEYOR BELTS:
1000' 60", 600' 30", 300' 20", 1600' 42", 500' 40", 1450' 36", 1200' 24", 900' 18", 600' 16", 350' 14"

CONVEYOR PARTS:
Idlers, Head & Tail Pulleys, Steel Frames, Tripper, etc., 14 In., 60 In. Large Stock in Jersey

SYNC. MOTOR GENERATORS:
100 KW Westgh. 900 RPM 3/60/2200-250-275
100 KW Ridgeway 1200 RPM 3/60/2200-250-275
150 KW G.E. 1200 RPM 3/60/2200-250-275
200 KW Ridgeway 900 RPM 3/60/2200-250-275

TUGGER HOISTS:
30 Ingersoll Rand Electric DD, 7½ HP, 15 HP, 20 HP, 35 HP & 45 HP
8 Sullivan Electric DD 15 HP, 20 HP, 25 HP, & 35 HP
6 Ingersoll Rand SD Air Tuggers

DRIFTER DRILLS:
75 Worthington 169 & 180, Ingersoll Rand X71 & S70 Gardner Denver 89B.

MACHINERY:
2', 5', 7', Symons Cone Crushers
36x20 Diamond Crushing Rolls
120 Flat & Dump Cars, 1 to 5 ton
Model 20A, 30A & 50 & 60 Conway Muckers
110 H.P. Ingersoll Rand Diesel Engine
5—Tyler Hummer Vibrating Screens, 4x5 & 4x8
Sullivan Loading Slide with Sullivan Hoist
Ball Mills: 3'x36", 7'x22", 8'x22" & 8'x10'
Jaw Crushers: 9x16, 6x20, 10x20, 11x20, 10x30, 18x36, 15x36, 24x36, 28x36, 24x48, 36x48, 42x48, 48x60, 66x86, 30x18, 7x10, 6x20.
6—Kennedy 19, 25, 37 & 49 Crushers.
7—I.R.—40, 50 & 52 Sharpeners.
7½, 15, 20 & 30 KW. Battery Chargers.

R. C. STANHOPE, INC.
60 East 42nd St. **New York, N. Y.**

BARGAINS

IN TRADE-INS AND REPOSSESSIONS

FOUR No. 6 Wilfley Concentrating Tables with motor drives.

ONE No. 20 Conway Loader.

TWO Model 11 Eimco-Finlay Loaders.

ONE 6' x 22" Hardinge Conical Ball Mill with 50-H.P. slip-ring motor direct-connected through herringbone gears.

ONE Single Drum 50 H.P. Electric Mine-Hoist Complete, 440 Volt Motor and Control.

TWO New 54" dia. Cast-Steel Sheaves with renewable liners in rope-grooves and Max-El Steel shafts.

The EIMCO Corporation
Box 300, Salt Lake City, Utah

BALL MILL: 1—4'x7' steel lined with feeder, fan, etc.
CRUSHER: 1—56"x84" all steel new condition.
ROLL CRUSHER: 1—Allis Chalmers 16" face 36" diameter chrome steel shells.
COMPRESSOR: 1—Ingersoll Rand XCB 9¼x12x15 with 100 H.P. AC motor, short belt drive, intercooler, four step control, used only 600 hours.
DIESEL ENGINES: 2—450 H.P. Cooper Bessemer 4 cylinder, 15x22, solid injection, 4 cycle, 225 RPM with or without 300 KW 2200 volt AC generator.
LOCOMOTIVES: 2—Vulcan 55 ton steam, standard gauge, power reverse, air operated fire doors, air brakes, built 1933, used 11 months.
MINE HOISTS: 2—single drum 84x72" face and 78x74" face with 350 H.P. AC motors. 1—68" diameter with 150 H.P. AC motor.
CRANES OVERHEAD ELECTRIC: 2—10 ton capacity 72'3" span, cage control, bucket operating, 220 volt DC with or without 2 yd. clamshell bucket.
PUMPS: 1—Allis Chalmers 10" suction 8" discharge, capacity 3500 GPM at 200' head with 250 H.P. slip ring motor, 1750 RPM complete.

A. J. O'NEILL
LANSDOWNE THEATRE BLDG.
LANSDOWNE, PA.
Phone: Philadelphia Madison 7578

Steel STORAGE TANKS

Railway Tank Car Tanks

Mfrs. pressure 60#. Underwriters' certificates furnished.

DELIVERED, and anytime, YOUR FOUNDATIONS, if desired!

6,000 to 10,000 gallons. Piped or non-piped.

A much better "buy" than new (lighter) tanks assured

Whole tank cars too. Would "portable" storage be cheaper and more advantageous for your particular needs? Just get our prices on both tanks and cars before you buy elsewhere.

IRON & STEEL PRODUCTS, INC.
13476 S. Brainard Ave., Chicago, Illinois
Cars and Locomotives; all types—Car Parts—Machinery & Equip.—Etc.
"Anything containing IRON or STEEL"

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of over 12,700 readers of the ENGINEERING and MINING JOURNAL.

Your problems of mine management, production, or operation—whether business or individual—are duplicated with *other* readers, but—

Still OTHER readers can provide the solution of your problem IF THEY KNOW WHAT IT IS!

Tell them! Here!

Through classified advertising in the Searchlight Section of the ENGINEERING and MINING JOURNAL — your business paper and *theirs*.

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STORAGE BATTERY

LOCOMOTIVES

1½ to 10 Ton—15" to 56" Track Gauge
GREENSBURG MACHINE CO.
Greensburg, Penna.

FOR SALE
MINING MACHINERY

Motors, A.C. and D.C., ¼ H.P. to 150 H.P. Transformers, 1 KVA to 100 KVA; Air Compressors; Belting; Blowers; Circuit Breakers; Conveyors; Crushers; Drills; Derricks; Fans; Generators; Grinders; Hoists; Lathes; Locomotives; Mining Machines; Pumps; Reels; Starters, AC and DC; Substations; Tipple Equipment; Wheel Presses.
GUYAN MACHINERY CO., Logan, W. Va.

CENTRIFUGAL PUMP

Dayton-Dowd, 24"x20" Type A-25 Centrifugal Pump with Westinghouse 200 HP, 208-Volt, 60 Cycle, 3-Phase Motor, with Starting Equipment, Priming Pump, and Priming Pump Motor.

Lew Morris Demolition Co., Inc.
41-50 22nd Street, L. I. C., N. Y.

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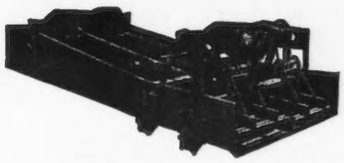
received by Jan. 3 will appear in the January issue, subject to limitations of space available.

Address copy to the Departmental Advertising Staff
Engineering and Mining Journal
330 West 42d St., New York City

"SEARCHLIGHT" is the "OPPORTUNITY"
advertising of this industry.



MORSE RECONDITIONED MACHINERY

DUPLEX CLASSIFIER
1—36″x14′-10½″ Dorr "Multizone"
1—15″x12′ Type "C" Simplex
1—20″x14′8″ Type "C" Simplex
1—54″x16′8″ Type "C" Simplex

AMALGAMATORS
1—24″x36″ Clean-up Barrel, M. & S. S.
1—No. Gibson Impact, 30 tons capacity
1—18″x24″ Denver Amalgam Barrel
1—36″x42″ Amalgam Barrel
1—17″x24″ Pierce, 20 tons dry ore
1—150-300-Ton Clark-Todd

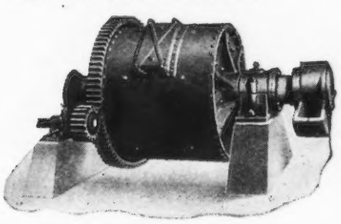
REDWOOD TANKS
All Sizes—Made of Heart Lumber

FLOTATION MACHINES
8 Cell Denver Equipment No. 18, low head
No. 100—D. E. "Sub A," unit cell

CONCENTRATING TABLES
No. 12 Wilfley—Timber underframes
½ size Baker—steel underframe
99—No. 6 or 11D Tables
7—Deister-Overstrom—diagonal deck
4—No. 3 Deister slime tables

DRILL SHARPENERS
3—No. 50 Ingersoll-Rand
1—No. 3 Leyners
1—No. 5 Leyner—I.R.

ELEVATORS
16″x24′ Centers, Belt and Bucket
8″x18′ Centers, 6″x4″ Buckets
7″x18′ Centers, 6″x4″ Buckets
9″x20′ Centers, 9″x7″ Buckets



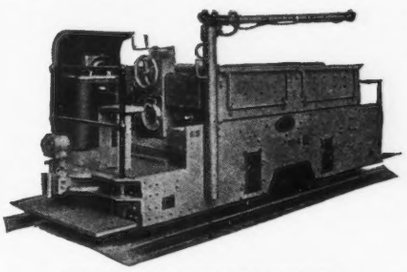
BALL MILL
1—4′x3′ High Pulp Discharge
1—4′x4′ Dewco continuous mill
1—5′x4′ Colo. Iron Wks. belt drive
1—5′x5′ "Dewco" belt drive
1—5′x7′ Chalmers Tube Mill
1—5′x9′ Colo. Iron Wks. belt drive
2—5′x16′ Colo. Iron Wks. Tube Mill
5—5′6″x22′ "Smidth" Tube Mill
1—No. 64½ Marcy Mill
1—7′x6′ Allis-Chalmers Ball Mill
1—7′x10′ Allis-Chalmers Ball Mill

ROCK BIT GRINDER
Type "D" Heavy Duty—Massco 18″

ELECTRIC VIBRATING FEEDER
No. 3 Jeffrey-Traylor—¼ h.p. to operate

SAND PUMPS
3—2″ Wilfley—direct connected
3—3″ Wilfley—direct connected
1—4″ Traylor, horizontal, belt driven
1—6″ Morris, 31 cubic yards per hour
1—6″ Krough, solid lined
1—6″ Wilfley, direct connected
1—8″ Goulds, 56 cubic yards per hour

THICKENERS
1—48′x8′ Dorr Bridge Superstructure
1—7′x3′ Thickener Steel Tank
2—24′x8′ Lowhead—motor drive
1—24′x10′ Lowhead—Redwood Tank
1—20′x12′ Dorr—Redwood Tank
1—15′x19′ Tray—4 compartment



TROLLEY LOCOMOTIVES
11—3-ton Jeffrey, cast iron frames
5—3½-ton Jeffrey, cast iron frames
1—3½-ton Baldwin—2 motors
1—4-ton G.E., M.P.H. 6.5
15—6-ton Jeffrey—armor plate
3—6-ton Goodman—class O
4—6½-ton G.E., 36″ gauge

BATTERY LOCOMOTIVES
3—2½ to 3½ Ton Mancha
1—3½ Ton Mancha Model Titan "A"
2—3½ Ton Atlas Type "B"
3—4 Ton Atlas Type "A"
4—5 Ton General Electric
3—6 Ton Goodman Class D
2—7 Ton Mancha Type Hercules

DRYERS
2—42″x25′ Flynn & Emrick rollers
1—36″x14′ Ruggles-Coles revolving
1—4′6″x45′ Stearns-Rogers
1—5′x45′ Reeves, rollers & tires
1—66′x26′ revolving dryer
1—15½″x6′0″ revolving dryer
2—36″x14′ Ruggles-Coles
1—48″x45′ revolving dryer
1—54″x21′6″ direct heat rotary

CRUSHING ROLLS
1—Triplex 9″x3″ housing and feed hopper
2—20″x12″ Colo. Iron Wks. Belt Drive
1—20″x12″ Dewco Convertible type
1—27″x14″ F.M. Davis Standard
1—30″x14″ Traylor type "A"
2—36″x16″ Davis Standard
1—36″x16″ Dewco Convertible
5—40″x16″ Colo. Iron Wks.
2—42″x14″ Allis-Crushing Rolls

DRAG LINE BUCKETS
1—2 yd. Full Bottom, Open Top
1—1⅓ yd. Bottomless, Scraper
2—1¼ yd. Clamshell, Owens Type M
2—¾ yd. Scraper, Bottomless
1—¾ yd. Bowl Type Bottom
1—1 yd. Straight Bottom

BULLETIN NO. 401 E
YOUR ENTIRE FLOWSHEET FROM DEPENDABLE RECONDITIONED STOCK.

ROASTERS
1—22x7 hearth wedge
1—22x8 hearth skinner
1—60″x96″ Bruckner roasting cylinder
1—6x16′ Bruckner rotary

CRUSHERS
9″x14″ "Semi Steel" Universal
3″x36″ Cedar Rapids
8″x24″ Universal, steel frame
14″x36″ Cedar Rapids
13″x24″ Telsmith-Wheeling, roller bearing, V-belt drive
15″x24″ Universal Steel Crusher

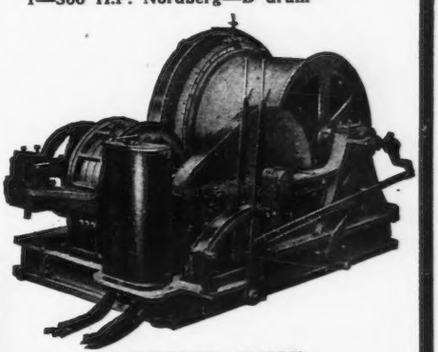
VIBRATING SCREENS
4—Type "33" Tyler Hum-mer Electric
1—Type FB2 Single Deck Traylor
1—40″x60″ Mitchell Electric Single
1—4′x10′ Traylor Single Deck
1—4′x6′ Newago Shaking Screen
2—No. 2 Sturtevant-Newago, 5½′x6′
1—Type "K" Sturtevant 8′x6½′
1—Tyler, Double Unit Whip Tap

DRUM FILTERS
1—6′x4′ Portland—with Agitator
1—8′x6′ Oliver—with Agitator

AIR COMPRESSORS
1—18x11x12″ Laidlaw - Dunn - Gordon, 2 Stage
1—340 cu. ft. Gardner-Denver
1—487 cu. ft. Bury
1—637 cu. ft. Sullivan
1—800 cu. ft. Ingersoll Rand
1—342 cu. ft. Blaisdell
1—648 cu. ft. Laidlaw-Dunn-Gordon
1—302 cu. ft. Sullivan

FILTER PRESSES
1—18″x18″ Perrin Filter Press
1—30″x30″ Shriver & Company Filter Press
1—32″x32″ Smith Vaille Filter Press
2—34″x34″ Merrill Sluicing Clarifying Filter Presses

ELECTRIC HOISTS
3—10 H.P. single drum
6—20 H.P.—single drum—Vulcan
1—40 H.P.—Vulcan—single drum
1—50 H.P. CFI.—single drum
1—60 H.P. Vulcan—5 drum
1—No. 4½ Vulcan—double drum
1—75 H.P. Leyner—5 drum
2—100 H.P. Vulcan—5 drum
1—100 H.P. H. & B.—5 drum
1—50 H.P. Leyner—5 drum
1—300 H.P. Nordberg—D drum



ELECTRIC HOIST

1775 BROADWAY NEW YORK CITY

ESTABLISHED 1898

MORSE BROS. MACHINERY CO.

P.O. BOX 1708 DENVER, COLORADO, U.S.A. CABLE "MORSE"

DEPENDABLE RECONDITIONED MACHINERY — MINING ★ ELECTRICAL INDUSTRIAL ★ MILLING

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Bucchi C. & Cia. Ltda., Casilla 4603, Santiago, Chile, S. A.
Perrett & Brauen, Caixa Postal 288, Rio De Janeiro, Brazil, S. A.

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Discount of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

DISPLAYED—RATE PER INCH:

The advertising rate is $5.50 per inch for a. advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured ⅞ inch vertically on one column, 3 columns—30 inches —to a page. E.M.J.

New ADVERTISEMENTS received by 10 A. M. January 3rd will appear in the January (Domestic Edition) issue subject to space limitations

PHELPS OCCUPATIONAL BUREAUS

An extensive and successful world-wide Mining and Engineering employment service. Constant openings, U. S. and foreign, for Mining Engrs., mine, mill and smelter Supts., Foremen, Shifters, Surveyors, Assayers, Metallurgists, Mill Operators, Draftsmen, Chief Electricians, Master Mechanics, Repair men, etc. A quick, dependable, confidential service. No fee of any kind unless position accepted. 90% of positions offered and filled by wire. Write or wire full qualifications, age, experience, salary, etc.

Phelps Occupational Bureaus
U. S. Nat'l Bank Bldg., Denver, Colo.

REPRESENTATION IN INDIA

An American engineering company with own representative in India handling its equipment and process business is in a position to represent other American companies now doing business in India or seeking to enter this field.

Address RA 983 Engineering & Mining Journal, 330 W. 42 St., N.Y.C., N. Y.

EMPLOYMENT SERVICE

SALARIED POSITIONS. $2,500 to $25,000. This thoroughly organized advertising service of 31 years' recognized standing and reputation carries on preliminary negotiations for positions of the caliber indicated above, through a procedure individualized to each client's personal requirements. Several weeks are required to negotiate and each individual must finance the moderate cost of his own campaign. Retaining fee protected by a refund provision as stipulated in our agreement. Identity is covered and, if employed, present position protected. If your salary has been $2,500 or more, send only name and address for details. R. W. Bixby, Inc., 264 Delward Bldg., Buffalo, N. Y.

POSITIONS WANTED

(See also "Selling Opportunity Wanted")

MANAGER-SUPERINTENDENT. Experienced Engineer in examination, exploration, development and operation of mining properties. Work has embraced the low-grade coppers, iron ranges, and precious metals. Have managed a custom mill. Graduate Engineer, Columbia University. PW-978, Engineering & Mining Journal, 520 N. Michigan Ave., Chicago, Ill.

CHEMIST-ASSAYER. Now operating custom assay office desires change of employers, technically trained with fifteen years experience in assay offices, laboratories and mills using the cyanide and flotation process, married, age 39, employment in United States, best of references. PW-981, Engineering & Mining Journal, 520 N. Michigan Ave., Chicago, Ill.

MINE SUPERINTENDENT—Graduate, age 36, married, speak Spanish, 14 years operating experience, familiar with all types of mining and development. PW-984, Engineering & Mining Journal, 520 N. Michigan Ave., Chicago, Ill.

ANALYTICAL CHEMIST. Mature. Thoroughly experienced, evaluation, identification of minerals, ores, metals. PW-985, Engineering & Mining Journal, 330 W. 42nd St., New York, N. Y.

BUSINESS OPPORTUNITIES

The Engineering and Mining Journal does not accept advertising relating to corporate financing.

Financial Backing Wanted

South American concessions. Engineer needs Partner with capital. Good prospects. BO-969, Engineering & Mining Journal, 330 W. 42nd St., New York, N. Y.

Lead and Barytes

Large body 40% ore 30 foot face 4 miles R.R. depot. Will sell a part or take partner. Need equipment. Q. O. Hunter, Osage Beach, Mo.

BUSINESS OPPORTUNITIES

Wanted to Lease or Finance

Manganese, vanadium, chrome or tungsten properties. Send plats, assays, full description, engineering report and proposition in first letter. R. E. Tippett, 1002 Barr Bldg., Washington, D. C.

Iron Ore Deposit

For Sale, Twenty-eight lode claims and millsite, seven patented, twenty-two patents granted about to issue. Total area approximately 580 acres. San Bernardino County, Calif. T 20 N R 10-E Ivanpah quadrangle. Principal minerals iron and talc. Deposit well proved by drilling and surface work. Terms can be arranged. For detailed information address The Pacific Dock and Terminal Co., 215 W. 6th St., Los Angeles, Calif.

For Sale Quicksilver Mine

Full or 50% interest in fully equipped quicksilver mine now producing between 1 and 1½ flasks per day. Location; Bottle Creek district, Nevada. Reply, 265 North Dayton Drive, West Los Angeles, Calif.

Manganese Property

for sale. In Virginia, favorable report by well known mining engineer, price and terms reasonable. BO-986, Engineering & Mining Journal, 330 W. 42nd St., New York, N. Y.

WANTED

WE BUY mineral specimens suitable for collectors, museums and study purposes, in lots of from ten to one hundred pounds. Write first. American Mineral Exchange, 212 Pacific Ave., Houston, Texas.

ANYTHING within reason that is wanted in the field served by Engineering & Mining Journal can be quickly located through bringing it to the attention of thousands of men whose interest is assured because this is the business paper they read.

IRON ORE DEPOSIT

For Sale, Twenty-eight lode claims and millsite, seven patented, twenty-two patents granted about to issue. Total area approximately 580 acres. San Bernardino County, Calif. T. 25 S., R. 10 E. Ivanpah quadrangle. Principal minerals iron and talc. Deposit well proved by drilling and surface work. Terms can be arranged. For detailed information address

THE PACIFIC DOCK AND TERMINAL CO.,
215 W. 6th St. Los Angeles, Calif.

WE LOOK INTO THE EARTH

By using Diamond Core Drills. We drill for coal and all other minerals. We make test-borings for bridges, dams, etc.

PENNSYLVANIA DRILLING CO.
Drilling Contractors
Pittsburgh, Pa.

IRON ORE

Have one thousand acres of land showing iron ore out-cropping in large quantities in Cook County, Minnesota twenty miles from Lake Superior. Surface rights sold to Government for National Forest, therefore no taxes. Will sell at reasonable price.

OSCAR A. ANDERSON
2507 Branch St. Duluth, Minn.

DIVIDEND NOTICE

ANACONDA COPPER MINING CO.
25 Broadway
New York, N. Y., November 28, 1940.
DIVIDEND NO. 130

The Board of Directors of the Anaconda Copper Mining Company has declared a dividend of Seventy-five Cents (75c) per share upon its Capital Stock of the par value of $50. per share, payable December 23, 1940, to holders of such shares of record at the close of business at 3 o'clock P.M., on December 10, 1940.

JAS. DICKSON, Secretary & Treasurer

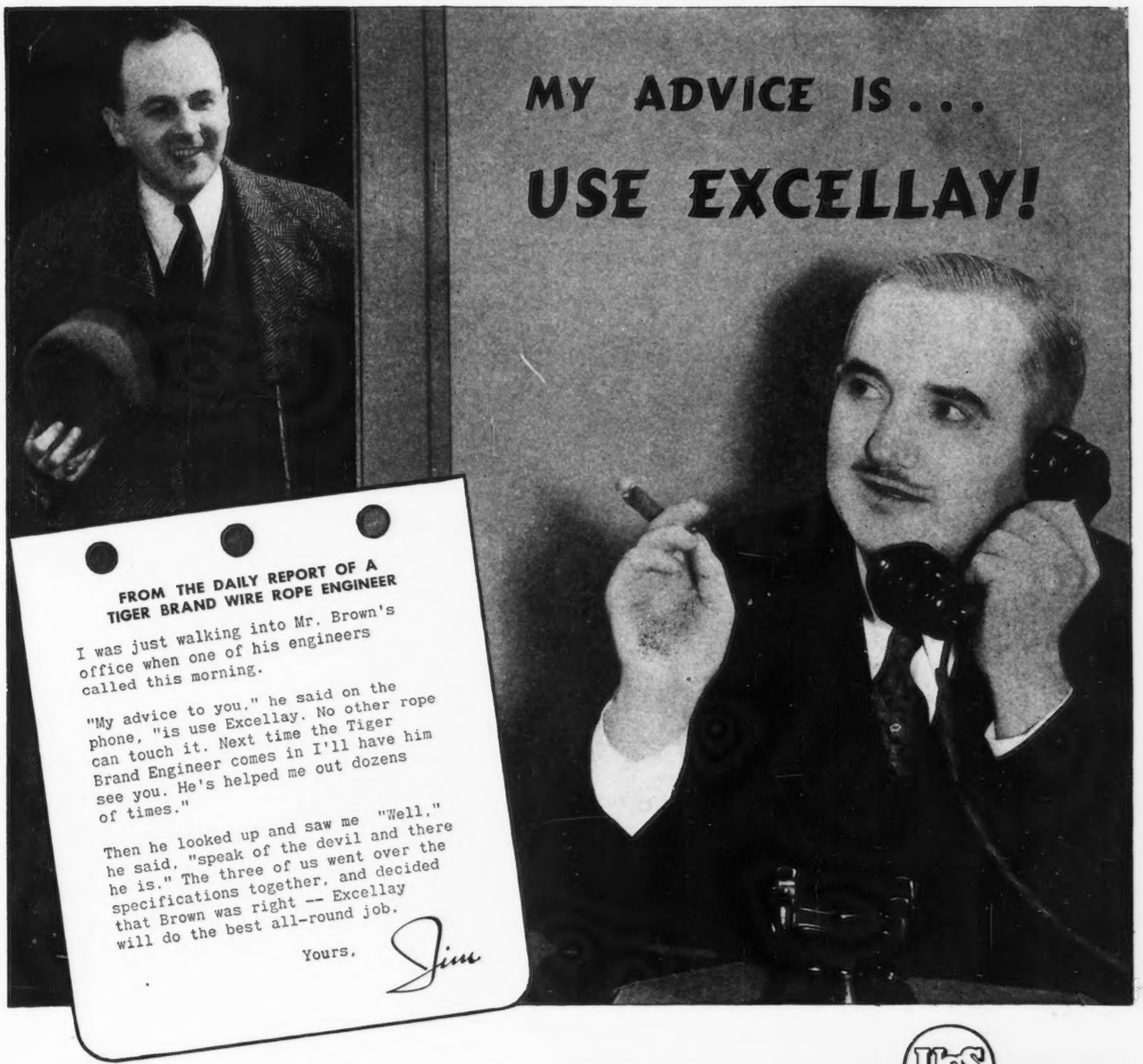
YOUR INQUIRY WILL HAVE SPECIAL VALUE

if you mention that it is in response to advertising in the Searchlight Section of ENGINEERING & MINING JOURNAL. Advertisers value such acknowledgments highly; so does the publisher. You benefit—as a reader—in the enlarged future service such acknowledgments help to make possible.

Departmental Staff

ENGINEERING & MINING JOURNAL

330 W. 42 St., N. Y.


MY ADVICE IS . . .
USE EXCELLAY!
FROM THE DAILY REPORT OF A TIGER BRAND WIRE ROPE ENGINEER
I was just walking into Mr. Brown's office when one of his engineers called this morning.
"My advice to you," he said on the phone, "is use Excellay. No other rope can touch it. Next time the Tiger Brand Engineer comes in I'll have him see you. He's helped me out dozens of times."
Then he looked up and saw me "Well," he said, "speak of the devil and there he is." The three of us went over the specifications together, and decided that Brown was right -- Excellay will do the best all-round job.
Yours,
Jim

KNOWING wire rope from A to Z—how to choose it and how to use it—that's the job of the American Tiger Brand Wire Rope Engineers. It will pay you to make use of their specialized knowledge and experience, gained through years of practical service to wire rope users in every industry, everywhere.

These men do more than help you select the right rope for a given application. If for any reason you are not getting full performance, they can help you locate the trouble and suggest practical ways and means for eliminating the difficulty. Get to know the American Tiger Brand Wire Rope Engineer who contacts you. Discuss your wire rope problems with him. Get his advice on every wire rope specification.

He can help you get a full dollar's worth of performance out of every dollar you invest in wire rope.

USS

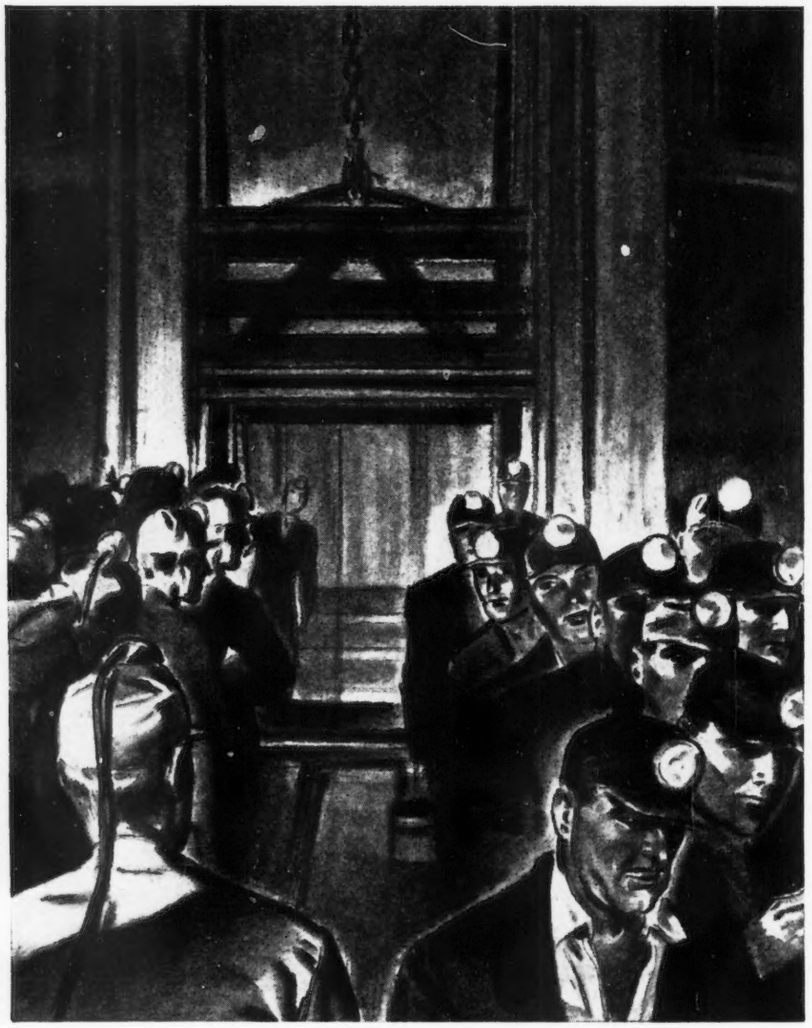
EXCELLAY
Preformed
WIRE ROPE

AMERICAN STEEL & WIRE COMPANY
Cleveland, Chicago and New York

COLUMBIA STEEL COMPANY
San Francisco

United States Steel Export Company, New York

UNITED STATES STEEL



MEN MAY COME AND MEN MAY GO

BUT MOTORS STAY AND WORK

YES, MOTORS stay and work as long as the insulation on their windings can resist the heat built up by continuous operation and peak loads. The proper magnet wire is a serious problem right now because motors in many mines are working to capacity.

Peak loads build up intense motor heat. Continuous operation allows no cooling-off periods. These conditions are very hard on motors wound with ordinary magnet wire. The insulation on that wire breaks down rapidly, and the motors stop. That means trouble and expense.

Deltabeston, Deltaglass, Formex Asbestos, and Formex Glass Magnet Wire can withstand the heat built up by peak loads and continuous operation. Deltabeston magnet wire performance is assured by the extreme purity of the asbestos used and the efficiency of the patented "felting" process which applies that asbestos to the copper conductor.

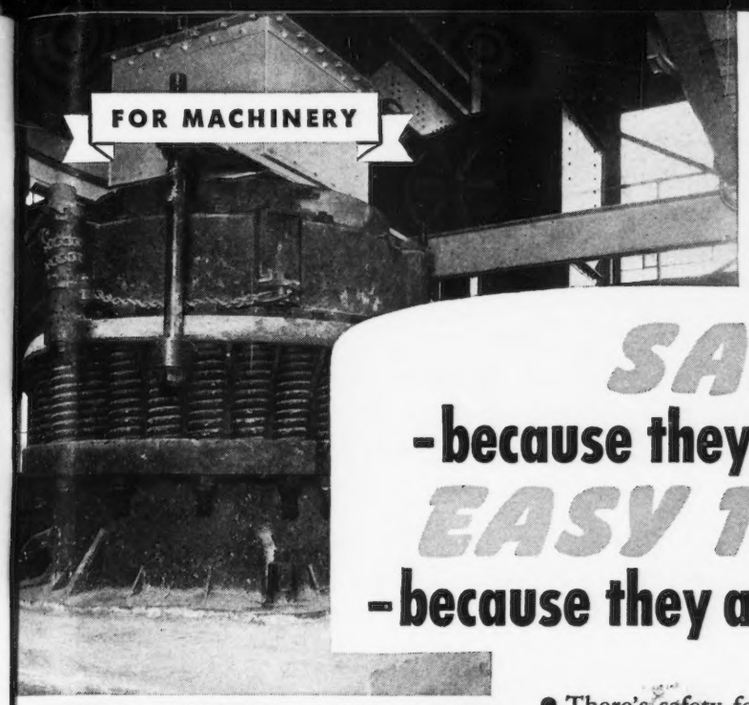
Deltaglass magnet wire possesses the inherent heat-resisting properties of spun glass. In addition, it is protected by special varnishes which greatly increase its dielectric strength.

Formex Asbestos and Formex Glass are high-quality G-E Magnet Wires with outstanding heat resistance.

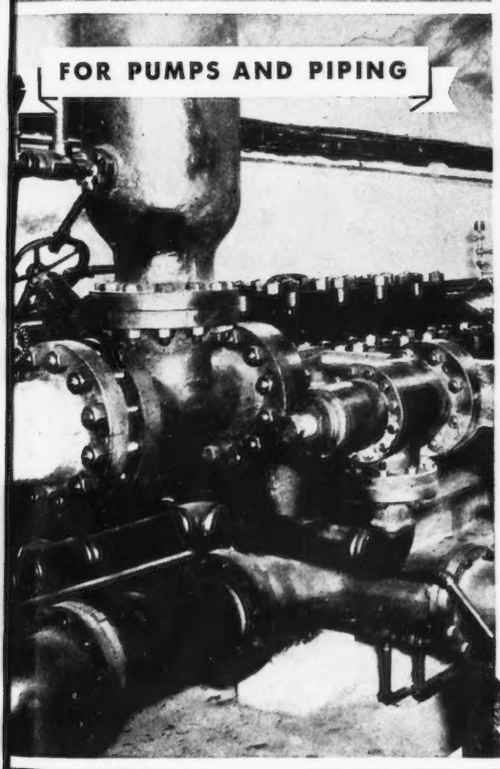
To cut down your motor repair bills, specify Deltabeston or Deltaglass magnet wire on your new motors. If your present motors must be sent out for rewinding, specify that Deltabeston or Deltaglass be used on them. Then when they come back to you they'll be ready to work for a long time in spite of the heat from peak loads and continuous operation.

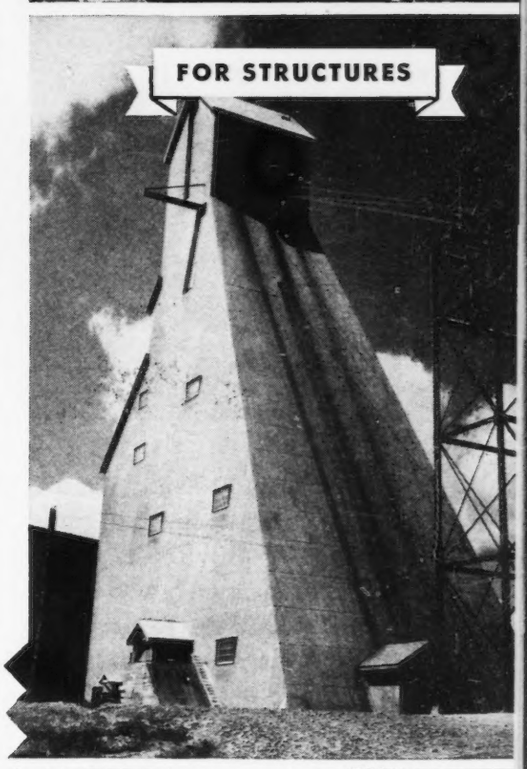
If you do your own motor repair work you can purchase these General Electric magnet wires from all G-E Merchandise Distributors and from the Graybar Electric Company.

GENERAL ELECTRIC



SAFE
-because they hold securely
EASY TO USE
-because they assemble quickly





● There's safety for your bolted or riveted equipment in Republic Upson Quality Headed and Threaded Products — bolts, nuts, rivets, turnbuckles, wire rope clips and other items. They're as strong or stronger than the materials they hold together — hence, they hold securely.

And Republic Upson Bolts are easy to use. Shanks are accurate in size. Heads and nuts provide full wrench fit — permit heavy wrenching. Threads are clean and sharp. Nuts turn on quickly and run freely to a tight grip.

To provide you with headed and threaded products for every use, Republic makes and stocks more than 20,000 items — produces bolts made of carbon and alloy steels, Enduro* Stainless Steel and rust-resisting Toncan* Iron. Your jobber can obtain the sizes and shapes you need promptly.

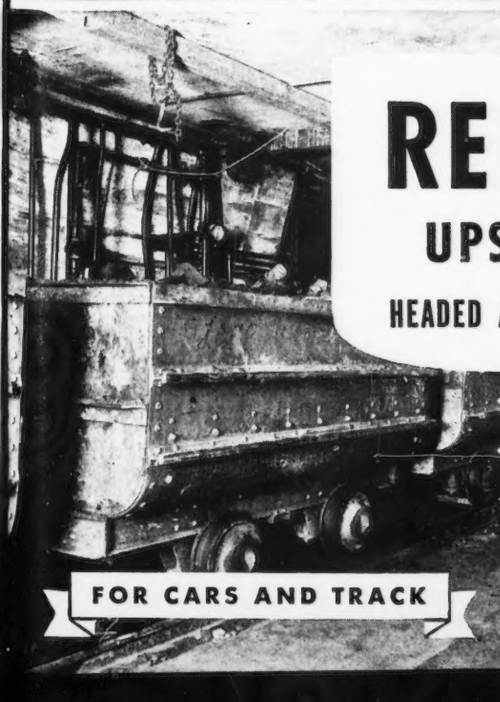
Catalog No. 307 will bring you sizes, weights, specifications, and other data. For a copy, write Republic Steel Corporation, Bolt and Nut Division, Cleveland, Ohio.

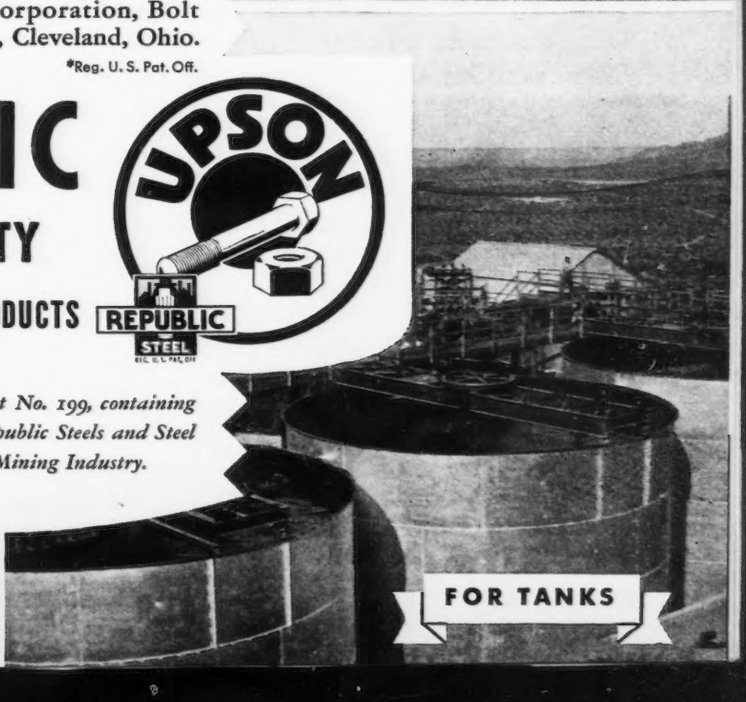
*Reg. U. S. Pat. Off.

REPUBLIC
UPSON QUALITY
HEADED AND THREADED PRODUCTS

UPSON
REPUBLIC STEEL
REG. U.S. PAT. OFF.

Let us send you Booklet No. 199, containing the complete list of Republic Steels and Steel Products for the Mining Industry.





VENTUBE* is pre-tested here...

for extra years of service here!

NO WONDER "Ventube" flexible ventilating duct is so amazingly durable! It is made of only the finest extra-heavy, long fibered cloth woven to specific standards set up by the Du Pont testing laboratories. The fabric and even the thread that goes into the making of "Ventube" are then processed with a special chemical treatment to resist fungus growth. Next, this fabric is impregnated and then coated with a resilient composition on both sides to resist acid water, gases and moisture!

Rigid chemical control and high Du Pont standards assure you of getting the best ventilating results possible with "Ventube." It is balanced in strength in both the warp and the filler direction so it can withstand tearing and rupture. It is light-weight, flexible, and easy to handle. "Ventube" slides back quickly when blasting. Immediately afterwards it slides forward again, bringing clean, fresh air into your tunnel with only the aid of a motor-driven fan of proper capacity.

"Ventube" saves time . . . helps you speed up work and cut costs. Install a few sections in your toughest working. See for yourself how efficiently it works. We'll be glad to send you facts and figures. Write to-day!

TUNE IN—CAVALCADE OF AMERICA
NBC RED NETWORK
EVERY WEDNESDAY EVENING

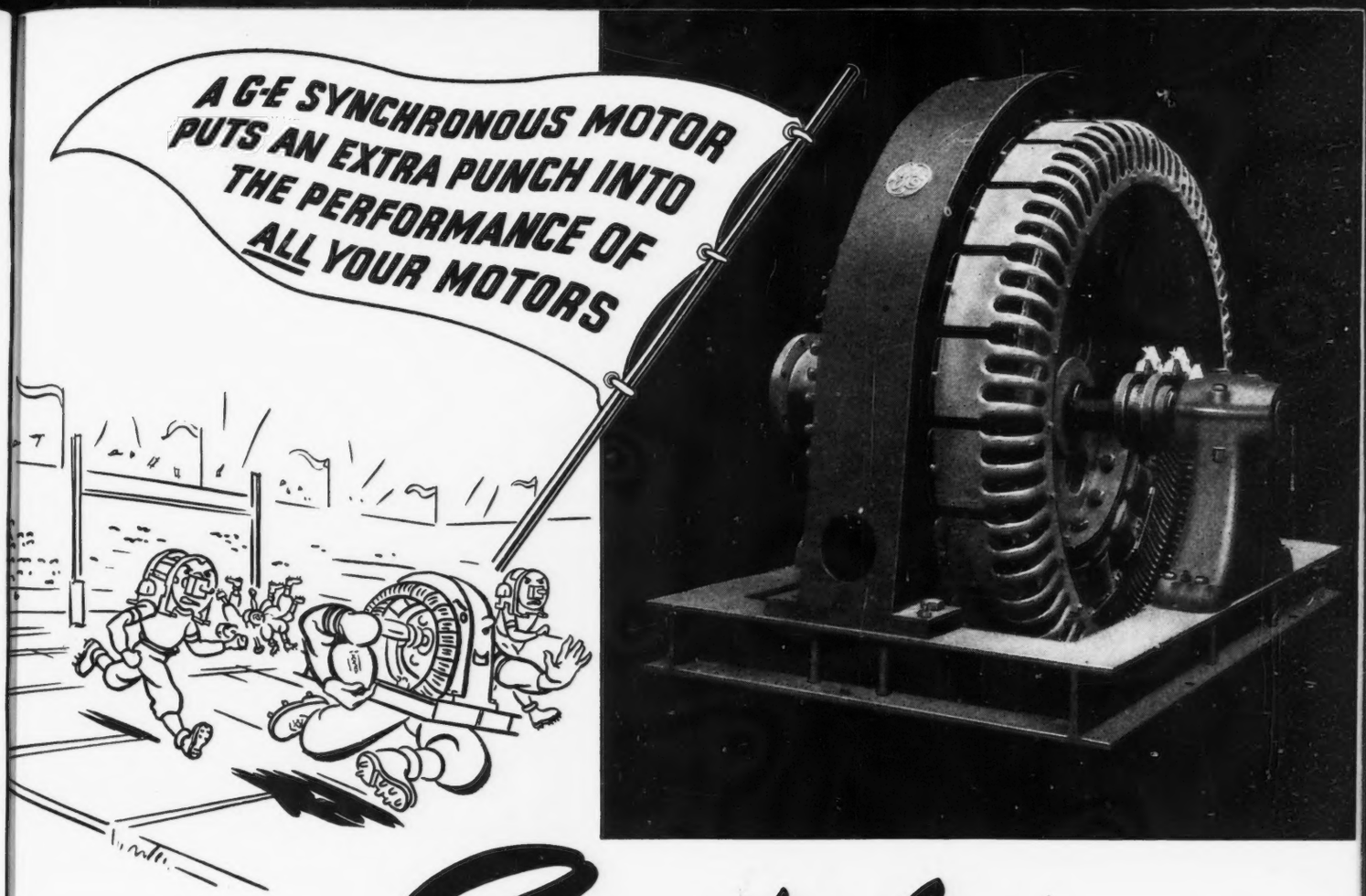
Du Pont also makes a complete line of powder bags from the same sturdy material as "Ventube." These bags are compact but roomy—and available in several serviceable sizes. Write Du Pont for complete information.

**"Ventube" is Du Pont's reg. trade mark for its flexible rubberized ventilating duct.*

E. I. du Pont de Nemours & Co. (Inc.)
"Fabrikoid" Division · Fairfield, Conn.
Hartley Bldg., Duluth, Minn.—Midland Savings Bank Bldg., Denver, Colo.

THE FLEXIBLE VENTILATING DUCT

DU PONT
REG U.S. PAT OFF
VENTUBE
REG U.S. PAT OFF



It's the *Sparkplug* of the Motor Team

INDUCTION MOTORS, of course, are a credit to any team. They're always in there fighting to give you continuous, low-cost operation. But if the performance of your induction motors has gone sour, put in a synchronous motor and you'll pep them up.

Subpar operation of induction motors—evidenced by unnecessary shutdowns, starting difficulties, running under normal speed—is very likely to be the result of reduced line voltage caused by a low power-factor condition. A synchronous motor will raise the power-factor and improve your operations generally.

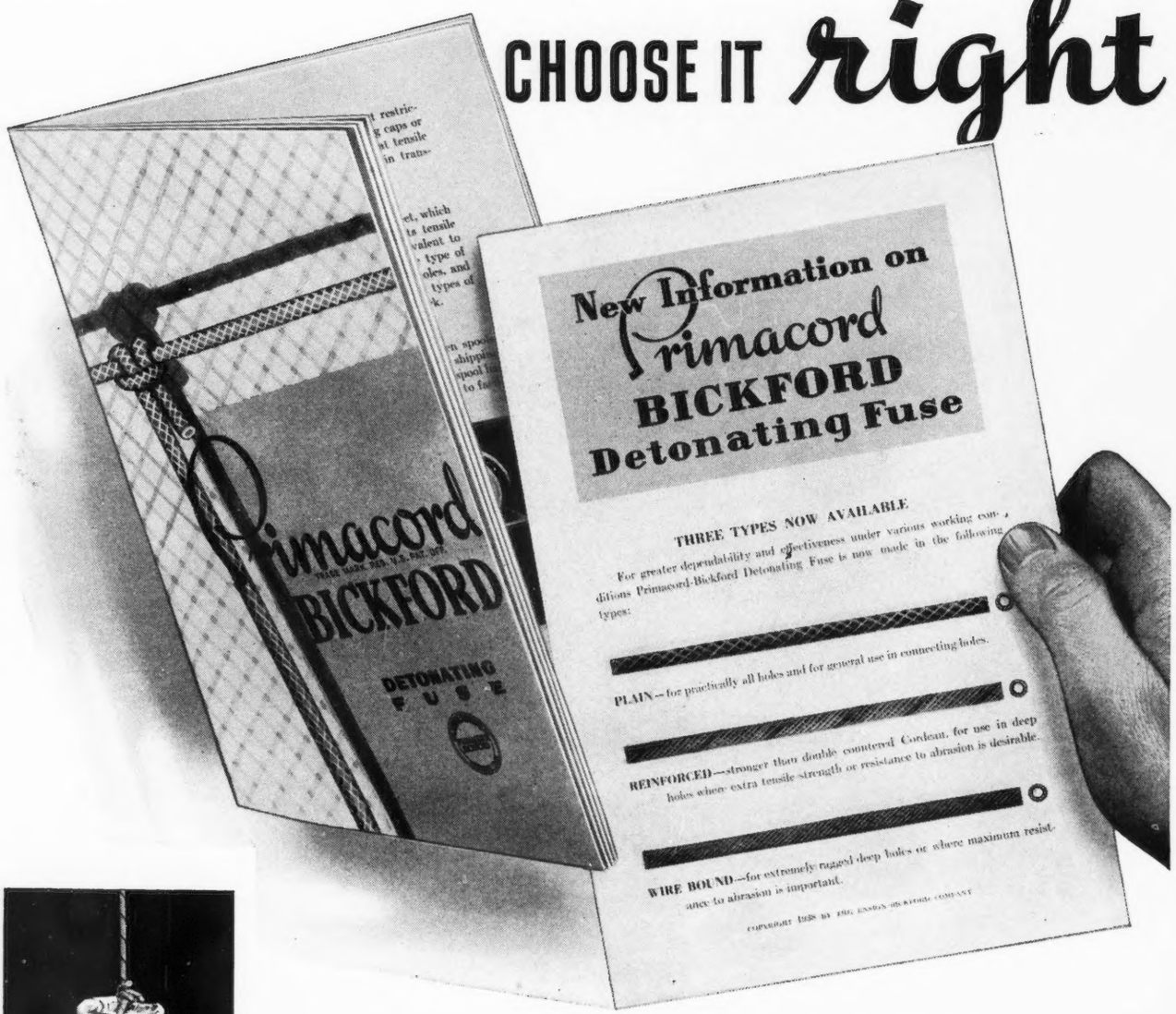
Synchronous motors are an excellent drive—high in efficiency and dependability—for compressors, pumps, ventilating fans, sintering fans, ball mills, tube mills, generators, or any other machine requiring a constant-speed drive. By improving power-factor they also save you the time, trouble, and expense of increasing circuit capacity. And, if you have a power contract with a power-factor clause, they may enable you to reduce your power cost materially.

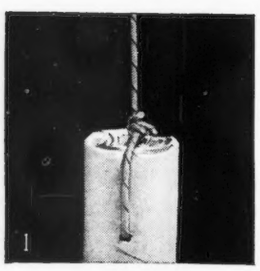
Whether you put a synchronous motor on a new machine or substitute one for an induction motor now in service, the investment will soon pay for itself many times over. Why not get in touch with our nearest representative and have him go over your requirements? General Electric, Schenectady, N. Y.

GENERAL ELECTRIC

660-10

CHOOSE IT *right*


Primacord
BICKFORD
DETONATING
FUSE
New Information on
Primacord
BICKFORD
Detonating Fuse
THREE TYPES NOW AVAILABLE
PLAIN—for practically all holes and for general use in connecting holes.
REINFORCED—stronger than double countered Cordeau, for use in deep holes where extra tensile strength or resistance to abrasion is desirable.
WIRE BOUND—for extremely rugged deep holes or where maximum resistance to abrasion is important.



Each of these three types of Primacord-Bickford Detonating Fuse has been developed to meet a particular need, as shown above. Check the job you have to do, and choose the right type of Primacord for that job.

Primacord carries a powerful detonating wave into each bore hole. Because Primacord is insensitive to friction, fire and ordinary shock, its storage, handling and hook-up are simplified; hazard reduced, economies effected, and greater efficiency obtained in large and intricate blasting operations.

We'll be glad to send you full information.

PRIMACORD·BICKFORD

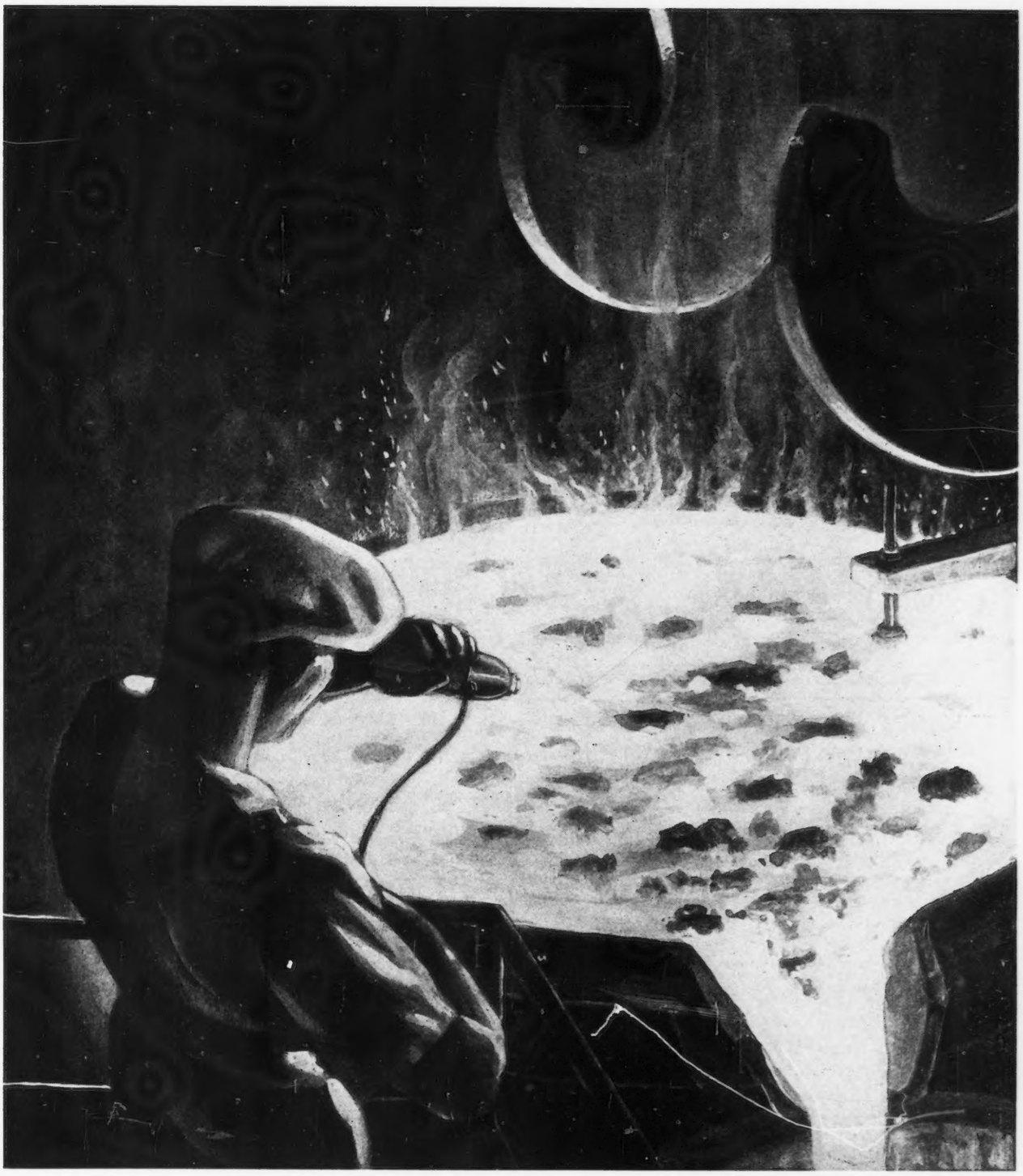
Detonating FUSE PB21

THE ENSIGN-BICKFORD CO., Simsbury, Conn.

Makers of Cordeau-Bickford Detonating Fuse — and Safety Fuse since 1836

1. Tie through cartridge.
2. Half hitch branch to main line.
3. Connect main line lengths with *square* knot.
4. Fuse and cap on end of main line.

Important: Branch lines should lead away from main lines at *right angles*. Avoid kinks and small loops.



Controlled Steel
for
Colorado Forged Steel Grinding Balls

CF&I STEEL

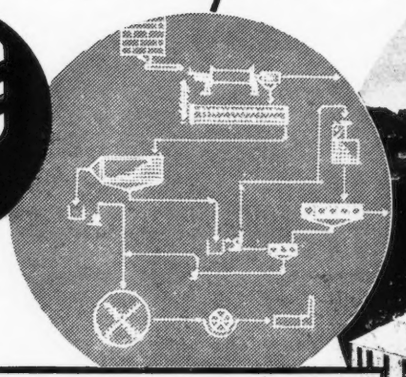
The Colorado Fuel and Iron Corporation

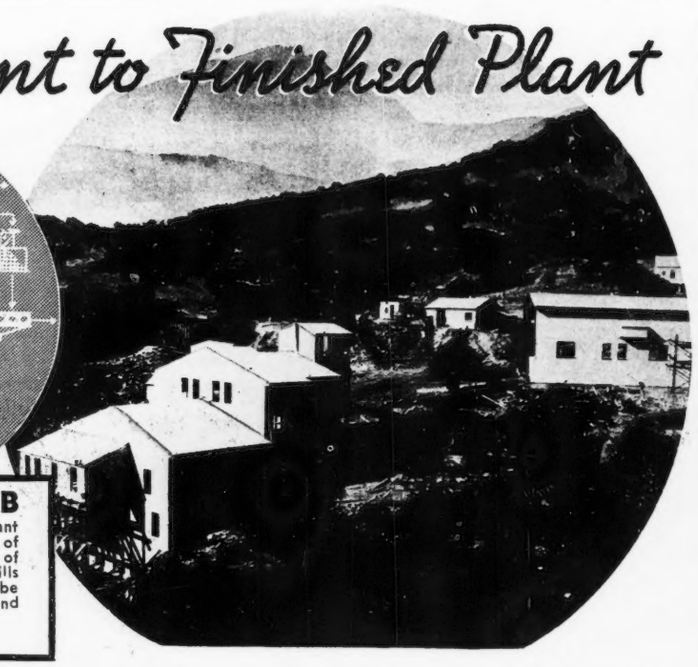
GENERAL OFFICE: DENVER, COLORADO

STEEL WORKS: PUEBLO, COLORADO

From Blueprint to Finished Plant

WKE





LET US ENGINEER YOUR JOB

It is a matter of pride with us that a majority of the important mines and mills in the West are WKE-built. Into everyone of them has gone the practical knowledge gained through years of actual experience in designing, building and operating mills and plants. That is one reason why your next mill should be WKE-built. Other reasons are: speed, dependability and economy.
Drop us a line and "let's put our heads together."

WESTERN KNAPP ENGINEERING CO.

CONSTRUCTION ENGINEERS – COMPLETE MINE AND MILL INSTALLATIONS

760 Folsom St.
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A complete modern guidebook for the mining engineer engaged in field work

It covers geologic and mineralogic data, equipment and methods, and much practical information on all phases of the work.

Third Edition—Revised and Enlarged.

HANDBOOK FOR PROSPECTORS

By M. W. VON BERNEWITZ
Mining and Metallurgical Engineer

372 pages, 5 x 7½, 104 illustrations, $3.00.

Simply and concisely, from the pen of a man who himself has prospected for several years, this book presents both the scientific and practical data needed by the prospector. Everything is covered, from a description of the most efficient equipment to the application of geophysics to prospecting. Practical uses of geology and mineralogy are explained—minerals are covered fully as to their occurrence, description, detection and use. This new edition includes much new material on the testing of ores, detection and markets. All data are brought up to date.

McGRAW-HILL BOOK COMPANY, INC.

Aldwych House, Aldwych, London, W.C. 2 — 330 W. 42nd St., N. Y. C., U. S. A.

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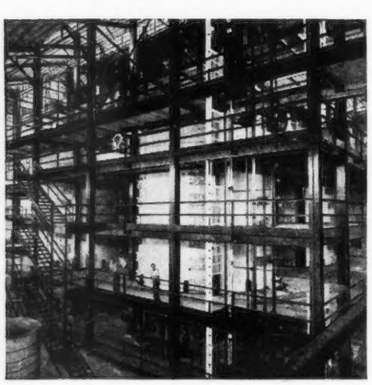


BETHLEHEM ROASTERS

are used in all parts of the world in the roasting of ores and concentrates, in drying and calcining processes preparatory to further metallurgical treatment, and in waste and by-product recovery. Full range of sizes—design to meet your requirements.

BETHLEHEM FOUNDRY & MACHINE COMPANY
BETHLEHEM, PA., U.S.A.

You Can't Drive a Spike

...with a Tack Hammer!

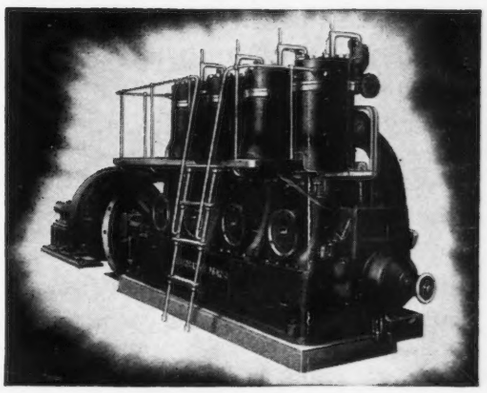
TACK HAMMERS are useful tools—but not for driving heavy spikes. That takes a *heavy-duty* hammer.

For heavy-duty power jobs, Fairbanks-Morse recommends the slow-speed, two-cycle, *heavy-duty* Diesel . . . for identically the same reason that you can't drive a spike with a tack hammer.

Slow speed reduces wear on moving parts. That is *important* where an engine must operate months on end without servicing. Maintenance cost records show just *how* important!

The simpler, two-cycle principle reduces moving parts to a minimum. Service is easier and costs much less. *Operating cost records prove* THAT, *too!*

Yes, where there's a hard job of work to be done—take a tip from the broadest Diesel experience in the world and *put a work Diesel on the job*—a Fairbanks-Morse Diesel of the s-l-o-w-speed, two-cycle type. For detailed information, write Fairbanks, Morse & Co., Dept. 27, 600 S. Michigan Ave., Chicago, Ill. Branches and service stations throughout the U. S. and Canada.



Model 32 Fairbanks-Morse Diesel; this is a slow-speed, 2-cycle engine built for heavy-duty service in mine, mill, factory—or wherever *long, continuous, heavy-duty, low-cost power* is a *must.*

7832-OA40.172

FAIRBANKS-MORSE

DIESEL ENGINES
PUMPS
ELECTRICAL MACHINERY
FAIRBANKS SCALES
RAILROAD EQUIPMENT
WATER SYSTEMS
WASHERS-IRONERS
FARM EQUIPMENT
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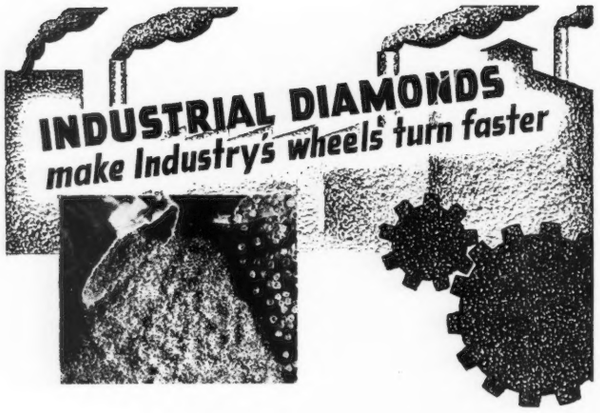
Diesels



Our tremendous national defense program added to the normal requirements of business, puts a serious problem up to Industry. The greatly accelerated demand for raw materials, including minerals, calls for full speed ahead in mining operations. In prospecting for ore, the tool best suited to rapid core drilling is the Ascolite Diamond Core Bit. This is a mechanically set Bortz bit, with the diamonds set in a special tungsten alloy which holds them securely and retains the shape of the bit without wearing down.

And we might add that the quality of Ascolite Bits is guaranteed by Anton Smit & Co., Inc., with a background of more than thirty years in the development of the industrial use of rough diamonds.

PRICES OF ASCOLITE BITS

	O.D.	I.D.	Carats	Price Per Bit
LM	1-3/8"	7/8"	6	$45.00
EXT	1-7/16"	31/32"	7	50.00
EX	1-7/16"	7/8"	8	55.00
AXT	1-27/32"	1-11/32"	11	75.00
AX	1-27/32"	1-7/32"	12	85.00
BX	2-5/16"	1-11/16"	15	100.00
NX	2-15/16"	2-3/16"	22	135.00

Payable in New York Funds F.O.B. New York.
10% of selling price is refunded for used bits when returned.

Testimonials from prominent users furnished on request.

ANTON SMIT & CO., INC.
24 STATE STREET (Near Battery) NEW YORK, N. Y.

Step-by-step procedures in the fire assaying of

gold, silver, the platinum and certain base metals

Here is a definitely helpful book for practicing assayers which gives workable procedures for the determination of gold and silver in almost any type of natural or artificial material. Complete schemes are given for the determination of the individual members of the platinum group; and a chapter is included on the preparation of bullion from amalgam and cyanide precipitates.

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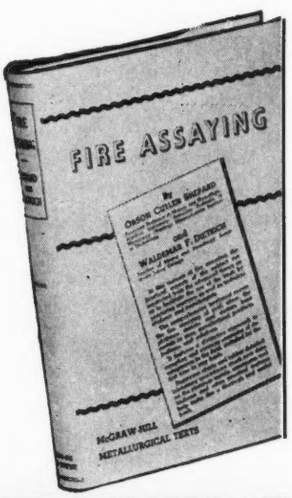

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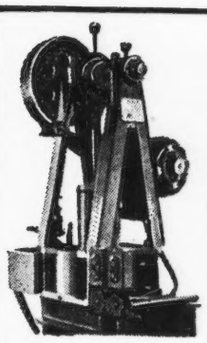

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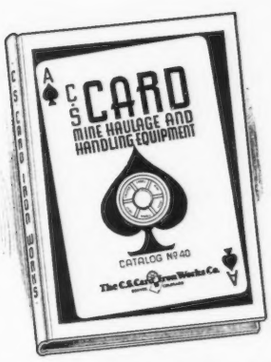

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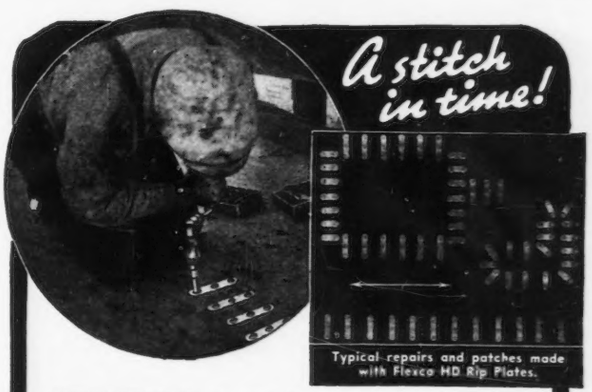

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Where † appears after a name the advertisement does not appear in this issue, but appeared in preceding issues.

	Page
*Allen-Sherman Hoff Co.	Second Cover
*Allis-Chalmers Mfg. Co.	6, 7
*Allis-Chalmers (Tractor Div.)	75
Alloys Co., The	96
American Brass Co.	98f
*American Brattice Cloth Corp.	†
*American Cable Div. of American Chain and Cable Co.	Third Cover
*American Cyanamid Co.	14, 15
American Hoist & Derrick Co.	96
*American Steel & Wire Co.	107
Anaconda Wire & Cable Co.	†
*Atlas Car & Mfg. Co.	82
Atlas Powder Co.	†
Bethlehem Foundry & Machine Co.	116
*Bethlehem Steel Co.	98b, 98c
*Boyles Bros. Drilling Co., Ltd.	97
Braun Corp.	†
Bristol Co., Mill Supply Div.	†
*Bucyrus-Erie Co.	17
Byron Jackson Co.	†
Carborundum Co.	100
Carboloy Co., Inc.	79
*Card Iron Works, C. S.	115
*Carnegie-Illinois Steel Corp. (Lorain Div.)	†
Caterpillar Tractor Co.	9
Chain Belt Company	†
Chicago Pneumatic Tool Co.	20, 21
Cleveland Rock Drill Co.	†
Climax Molybdenum Co.	†
Colorado Fuel & Iron Corp.	115
*Colorado Iron Works Co.	81
Columbian Steel Co.	107
*Coppus Engineering Corp.	†
Crane Co.	98g
*Deister Concentrator Co.	92
*Deister Machine Co.	96
*Denver Equipment Co.	95
*Denver Fire Clay Co.	85
Differential Locomotive & Car Works	†
Differential Steel Car Co.	†
*Dings Magnetic Separator Co.	†
Dixon Valve & Coupling Co.	88
*Dorr Co.	3
*du Pont de Nemours & Co., Inc., E. I. (Explosives Div.)	†
*du Pont de Nemours & Co., Inc., E. I. (Fabrikoid Div.)	110
*Eimco Corporation	28, 29
*Electric Storage Battery Co.	67
Engineering & Mining Journal	77
*Ensign-Bickford Co.	112
Fairbanks-Morse & Co.	117
Fiske Bros. Refining Co.	†
Flexible Steel Lacing Co.	119
Galigher Co.	22
Gardner-Denver Co.	11
*Garlock Packing Co.	†
Gates Rubber Co.	†
*General Electric Co.	111
General Electric Appliance and Merchandise Dept.	108
Gibson, W. W.	†
Goodrich Co., B. F.	122
Goodyear Tire & Rubber Co.	†
Gould & Co., H. W.	89
*Great Western Div. The Dow Chemical Co.	10
Greene, Tweed and Co.	101
Gustin-Bacon Mfg. Co.	121
*Hazard Wire Rope Div. (American Chain & Cable Co., Inc.)	98i
*Hendy Iron Works, Joshua	†
Hercules Powder Co.	†
Hewitt Rubber Corp.	†
Industrial Brownhoist	†
*Ingersoll-Rand Co.	18
International Combustion, Ltd.	†
International Nickel Co.	98d
*Jeffrey Mfg. Co.	93
*Laughlin Co., Thos.	†
*Leschen & Sons Rope Co., A.	†
LeTourneau, Inc., R. G.	13
*Link-Belt Co.	98k
*Logan Engineering Co.	†
*Longyear Co., E. J.	4
Lufkin Rule Co.	†
Mace Co.	†
MacWhyte Co.	98j
Manhattan Rubber Mfg. Div. of Raybestos-Manhattan, Inc.	†
Marion Steam Shovel Co.	†
McGraw-Hill Book Co.	118
McGraw-Hill Pub. Co., Direct Mail Div.	†
McLanahan & Stone Corp.	120
*Merrick Scale Mfg. Co.	96
Merrill Co., The	†
Metal & Non-Metallic Mining Catalogs	98
Midvale Co.	98h
*Mill & Mine Supply Inc.	93
*Mine Safety Appliances Co.	73
*Mine and Smelter Supply Co.	26
*Morse Bros. Machinery Co.	12
Mt. Vernon Woodberry Mills, Inc.	†
Naylor Pipe Co.	†
*Newport Industries, Inc.	103
New York Engineering Co.	102
*Nichols Engineering & Research Corp.	103
*Nordberg Mfg. Co.	8
Northwest Engineering Co.	23
Ohio Brass Co.	†
Ottumwa Iron Works	78
Owens-Corning Fiberglas Corp.	99
Pan-American Engineering Co.	84
Pomono Pump Co.	†
Precipitation Co. of Canada Ltd.	19
*Pressed Steel Car Co., Inc.	89
Republic Steel Corp., Alloy Steel Div.	109
Research Corporation	19
Robins Conveying Belt Co.	96
*Roebling's Sons Co., John A.	98e
Roots Connersville Blower Corp.	87
*Ross Screen & Feeder Co.	95
Ryerson & Sons, Inc., Joseph T.	120
Sanford-Day Iron Works, Inc.	101
*Sauerman Bros.	87
Sharples Solvents Corp.	†
Searchlight Section	104, 105, 106
SKF Industries, Inc.	98h
*Smit & Sons, Inc., J. K.	90
*Smit & Co., Inc., Anton	118
Smith Engineering Works	16
Smooth-On Mfg. Co.	†
Socony-Vacuum Oil Co., Inc.	†
Sorel Steel Foundries Ltd.	86
Southwestern Engineering Co.	†
*Sprague & Henwood, Inc.	102
Standard Oil Co. of California	†
Standard Pressed Steel Co.	90
Stephens-Adamson Mfg. Co.	†
Stearns Magnetic Mfg. Co.	80
Straub Mfg. Co.	97
*Sullivan Machinery Co.	24, 25
*Syntron Co.	101
Tamping Bag Co.	†
Taylor Forge & Pipe Works	102
Templeton Kenly & Co.	97
Texas Company	98-a
Timken Roller Bearing Co.	Fourth Cover
Traylor Eng. & Mfg. Co.	5
U. S. Steel Subsidiaries	107
Washington Iron Works	104
Western Knapp Engineering Co.	116
Western Machinery Co.	119
Western Precipitation Corp.	19
Westinghouse Elec. & Mfg. Co.	71
*Wilfley & Sons, Inc., A. R.	30
Williamson Co.	†
Yuba Mfg. Co.	83
Professional Services	102

SEARCHLIGHT SECTION

Classified Advertising

Classification	Page
BUSINESS OPPORTUNITIES	106
CORE DRILLING	106
DIVIDEND NOTICE	106
EMPLOYMENT SERVICE	106
MINES FOR SALE	106
POSITIONS VACANT	106
POSITIONS WANTED	106
PROPERTY FOR SALE	106
SELLING OPPORTUNITIES	106
USED AND SURPLUS EQUIPMENT	104-105
Consolidated Products Co., Inc.	104
Eimco Corp., The	104
Greensburg Machine Co.	104
Guyan Machy. Co.	104
Iron & Steel Products, Inc.	104
Morse Bros. Machinery Co.	105
Morris Demolition Co., Inc., Lew	104
O'Neill, A. J.	104
Stanhope, Inc., R. C.	104

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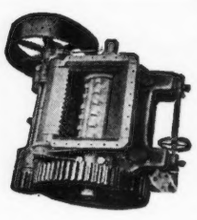

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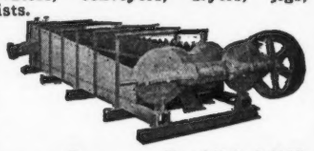

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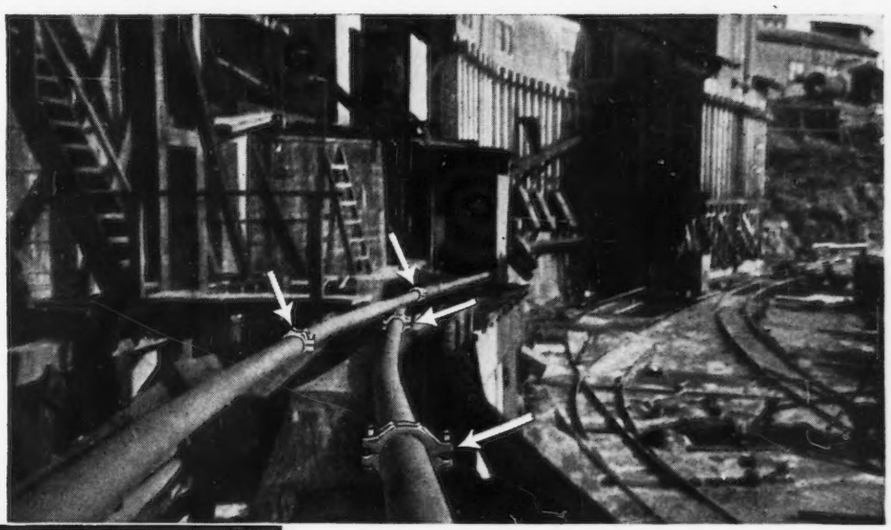

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Rolagrip Couplings overcome difficulties of joint pull-outs and breakage where pipe is subjected to high end-pulls due to pressure or other forces... may be used satisfactorily on vertical as well as horizontal lines.

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Rolagrip Couplings are made for pipe diameters ranging from 2" to 12" inclusive and for air, water, salt water, acid water, concentrate, gas or oil lines. Both rubber and synthetic gaskets are available.

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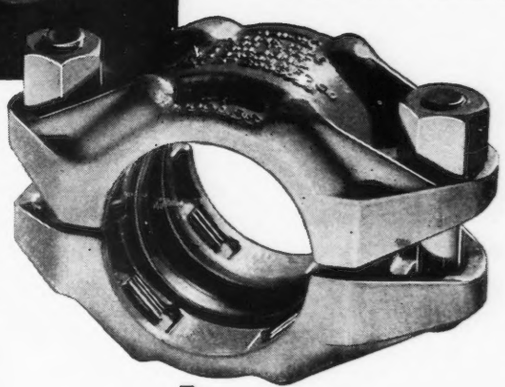
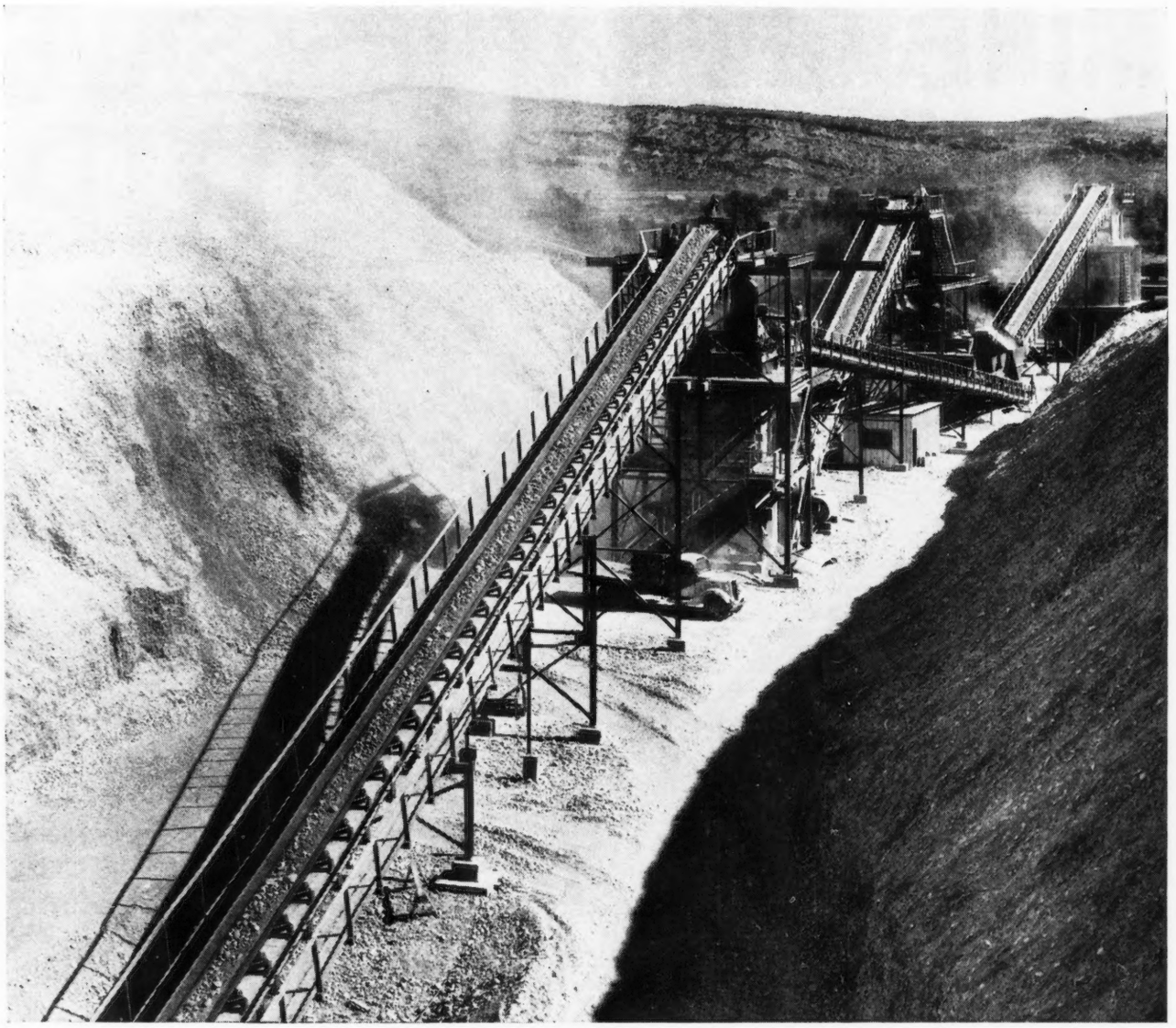
1 G-B Rolagrip Couplings mean SPEED and ECONOMY because: no threads, grooves or special ends are required; light-weight pipe can be used since none is cut away; Complete pipe and coupling can be salvaged; simplicity of connections speeds up installations.



2 Rolagrips are PRACTICAL because: they automatically accommodate expansion and contraction in the line; permit considerable angular misalignment; can be used on lines carrying up to 1000 lbs. pressure; and require no anchorage of the line or welding of tie bolt lugs on pipe to secure coupling.



The rubber roller coaster that takes mountains for a ride

A typical example of Goodrich development in rubber

TAKE a look at plants that furnish stone for roads, dams, bridges. Whole mountains of gravel are carried by rubber-and-cotton conveyor belts to crushers and screens, where rocks are crushed and sorted according to size.

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The new Goodrich belt was installed in the Wyoming plant in the picture. A test (not on the program) came the first day. A heavy crowbar caught in the belt, bent like a hairpin around the pulleys, and wedged against the framework where it would have ripped any other belt to useless shreds. But the Goodrich cords held until power could be shut off, and a $2000 belt was saved.

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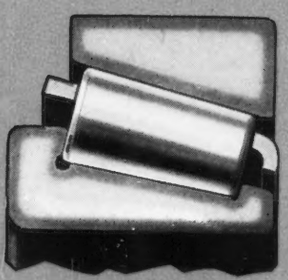

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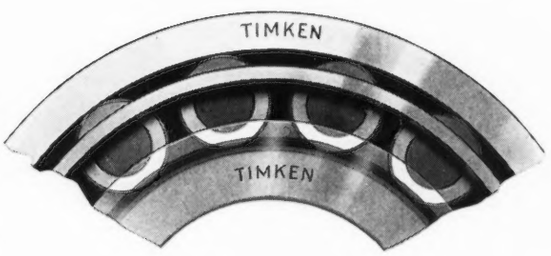

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